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KICKSTARTER
PATAGONIA
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KIVA and
LITTLEBITS'
AYAH BDEIR →
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By Kevin Kelly

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MAGAZINE

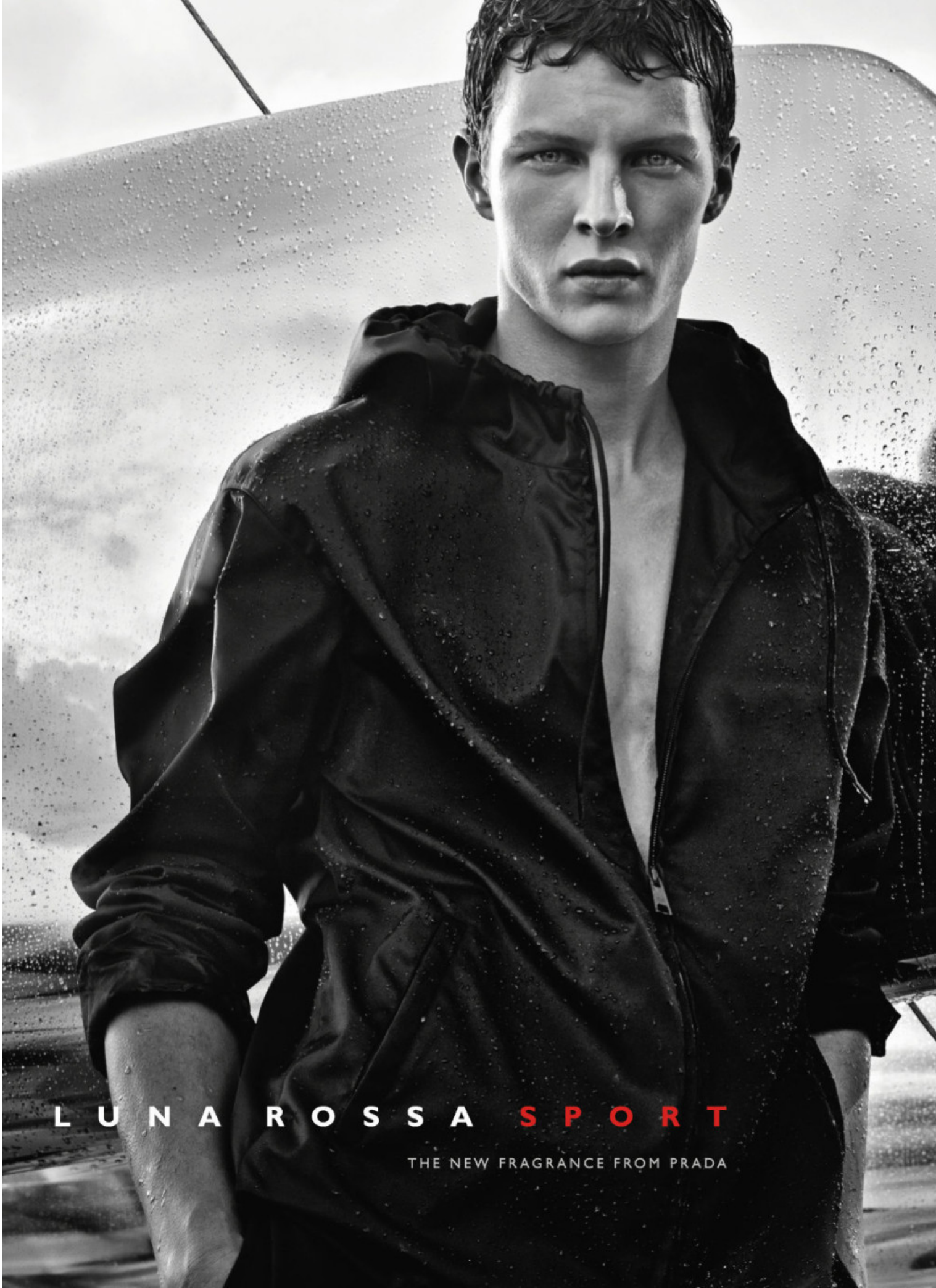
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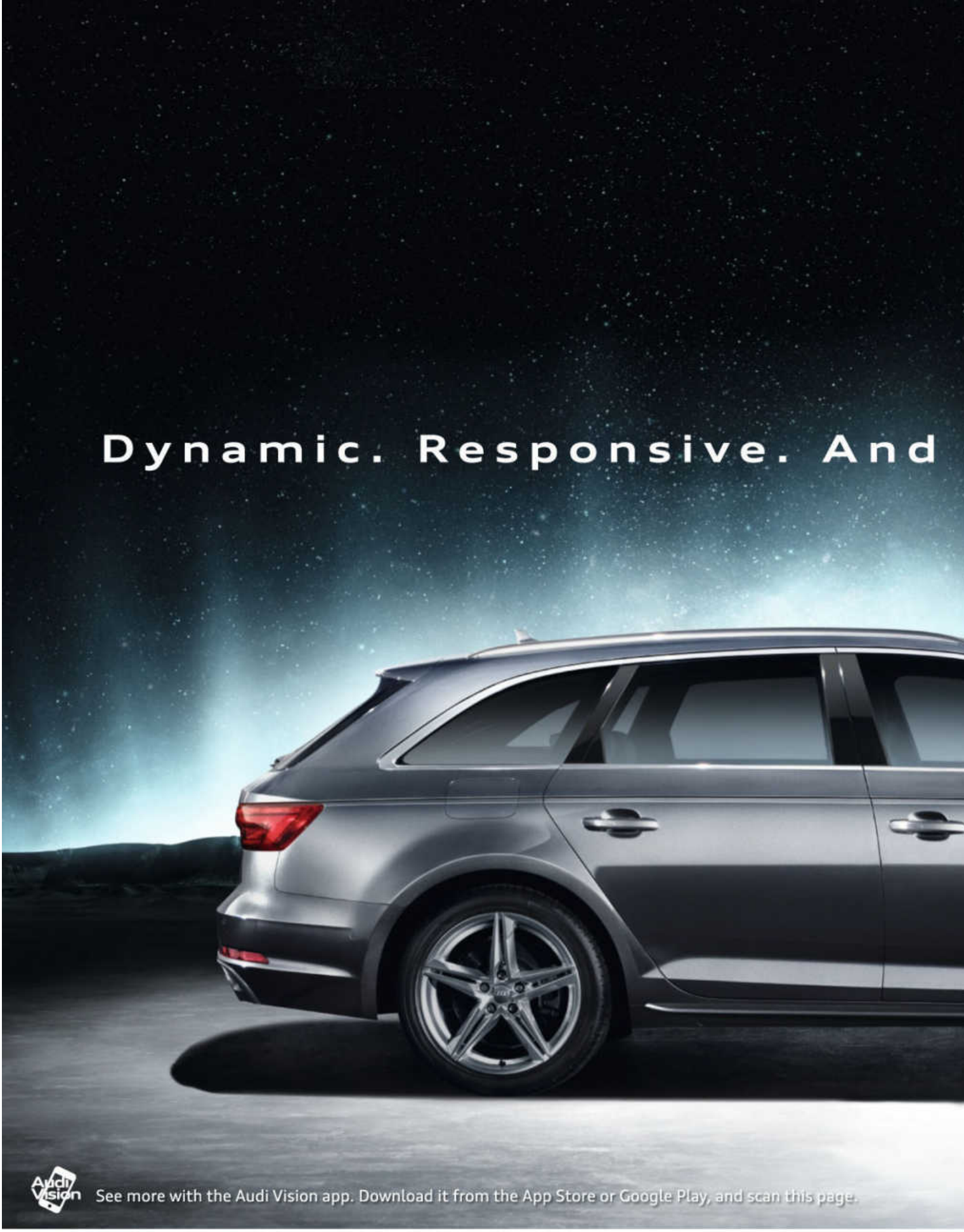
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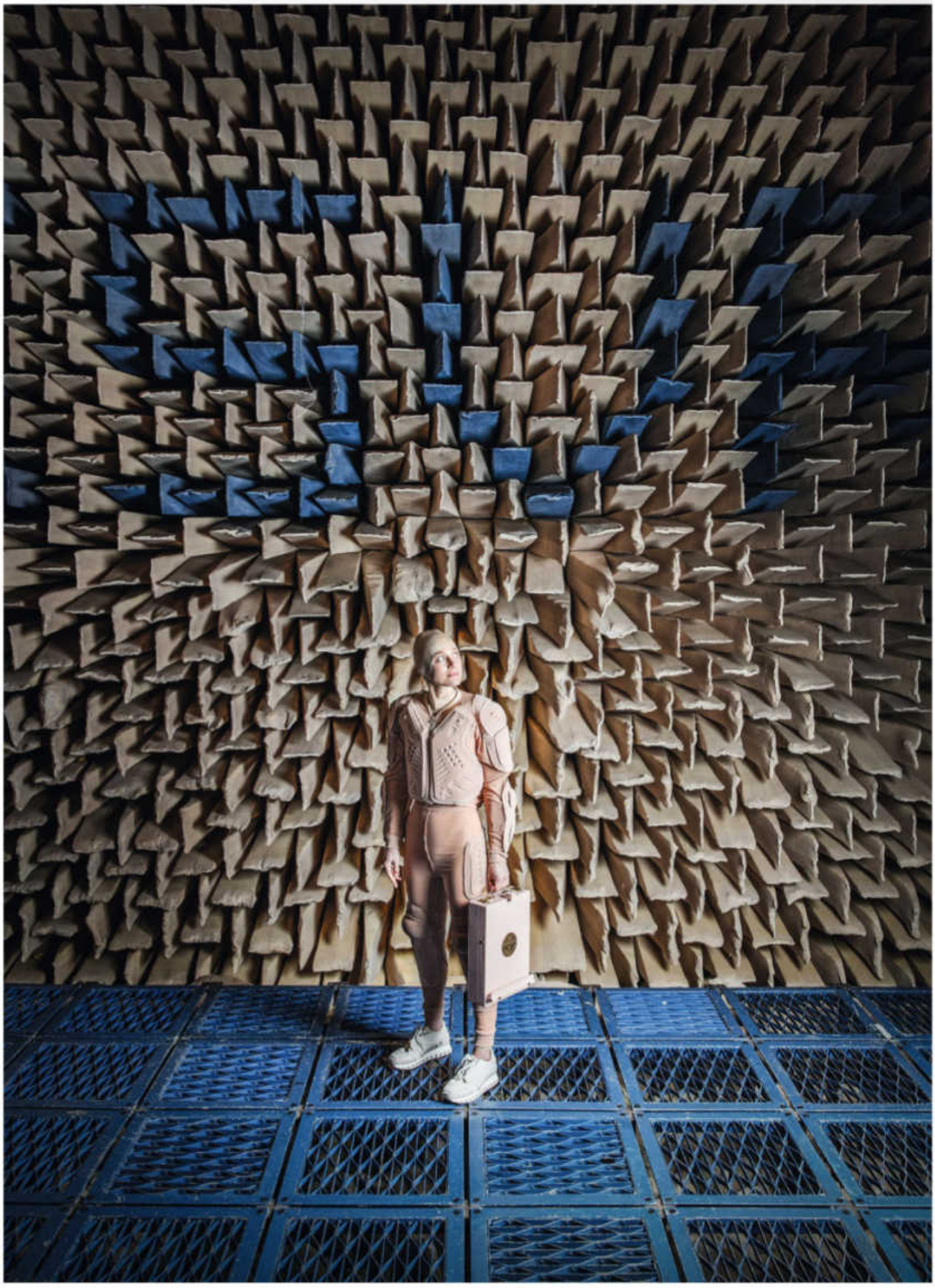
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COVER PHOTOGRAPHY: CHRIS CRISMAN. THIS PAGE: JULIAN LOVE

Lucy McRae prepares to perform her *Institute of Isolation* live piece

075

PLAY

This artist defies gravity

Lucy McRae bridges science and art in surreal ways – whether wrapping audiences in foil or defying Newtonian laws



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With luxuriously smooth driving dynamics, the intelligent Mitsubishi Outlander PHEV decides when it's more efficient to use petrol or electricity, giving it the ability to deliver a staggering 156mpg[1]. An electric range of up to 32 miles allows the Outlander PHEV to easily tackle the UK's average daily drive on a single charge – and on longer journeys the petrol engine helps out to achieve a combined range of up to 541 miles[2]. The battery can be charged in just a few hours via a domestic plug socket[3], a low-cost home Charge Point[4] or one of over 8,500 Charge Points found across the UK. With ultra-low CO_2 emissions the Outlander PHEV is exempt from Road Tax and the London Congestion Charge[5] – as well as being eligible for drastically reduced Benefit in Kind taxation[6]. There's even £2,500 off the list price through the Government Plug-in Car Grant, which means an Outlander PHEV will cost you from just £31,749[7].

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1. Official EU MPG test figure shown as a guide for comparative purposes and may not reflect real driving results. 2. Up to 32 mile EV range achieved with full battery charge. 541 miles achieved with combined full battery and petrol tank. Actual range will vary depending on driving style and road conditions.

3. Domestic plug charge: 5 hours, 16 Amp home charge point: 3.5 hours, 80% rapid charge: 30mins. 4. Government subsidised charge points are available from a number of suppliers for a small fee - ask your dealer for more information. 5. Congestion Charge application required, subject to administrative fee. 6. 7% BIK compared to the average rate of 25%. 7% BIK rate for the 2016/17 tax year. 7. Prices shown include the Government Plug-in Car Grant and VAT (at 20%), but **exclude First Registration Fee**. Model shown is an Outlander PHEV GX4hs at £38,499 including the Government Plug-in Car Grant. On The Road prices range from £31,804 to £43,054 and include VED, First Registration Fee and the Government Plug-in Car Grant. **Metallic/pearlescent paint extra**. Prices correct at time of going to print. For more information about the Government Plug-in Car Grant please visit www.gov.uk/plug-in-car-van-grants. The Government Plug-in Car Grant is subject to change at any time, without prior notice. 8. All new Outlander PHEV variants come with a 5 year/62,500 mile warranty (whichever occurs first) and an 8 year/100,000 mile traction battery warranty.

Outlander PHEV range fuel consumption in mpg (ltrs/100km): Full Battery Charge: no fuel used, Depleted Battery Charge: 51.4mpg (5.5), Weighted Average: 156.9mpg (1.8), CO_2 emissions: 42 g/km.

020

START
Still life of a frozen stem cell
A team at King's College London is using cryogenic scanning electron microscopy to capture close-ups of human stem cells

030

START
Inside Giphy's infinite loop
Alex Chung has taken the art of the clip and turned it into a $300 million empire that's expanded into licensed content

049

IDEAS BANK
Brain food & provocations
Why MOOCs need to expand minds; don't trust first impressions; slow futures; how Kim Kardashian could save your life

058

GEAR
Rated & reviewed
Slick new soundbars, tablet/laptop hybrids, skeletal chairs, cityscape tables, the Impossible Project's latest camera

071

PLAY
Print and shoot
Michael Sng hand-builds motorised toy tanks, such as the *HMC Boudicca*, using hundreds of 3D-printed parts

080

PLAY
Superstar UAVs
Nick Horbaczewski wants to make drone racing a global sport – and thinks 360-degree footage will do the trick

085

R&D
Scientific progress
Mapping the millennials; why 3D gaming may boost your brain; ditch your diet for your health; test cancer cells with a laser

092

PROFIT & PURPOSE SPECIAL
Do good. Make money
From Kickstarter to Kiva and littleBits, for-profit companies are growing by targeting social impact with a commercial mindset

112

FEATURE
Hyper vision
Kevin Kelly explores what Magic Leap's mind-bending technology tells us about the future of virtual reality

124

FEATURE
Home-as-a-service
After the co-working boom, co-living is the logical next step. WIRED embraces the trend and moves in (linen included)

132

FEATURE
29 points about PowerPoint
Russell Davies celebrates the much-maligned software's 29th birthday by pulling up 29 bullet-points in its defence

138

FEATURE
The (mundane) robot uprising
Service robots are about to take over the world. But first, humans need to teach them a some decent social skills…



Jurgi Camblong, co-founder of Sophia Genetics, uses machine learning to detect cancer (p26):
"The problem is analysing to find important information."

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WIRED LOGO: FOREAL. A PHYSICAL SIMULATION OF CLOTH WITHIN CINEMA 4D. CHARACTERISING A GOOD MORNING IN A BED WITH MANY WHITE PILLOWS



ISSEY MIYAKE

L'EAU D'ISSEY

POUR HOMME

THE WIRED UNIVERSE



INSTAGRAM

HIGHER STANDARDS

As if being a kung fu expert living in the shadow of the world-renowned Shaolin Monastery Buddhist temple in Dengfeng, China, wasn't impressive enough, these orange-clad residents of a local martial-arts school are practising their moves halfway up the local vertical cliff face. Come on, that's just showing off... To see more awe-inspiring images from the WIRED world, updated daily, **follow @wireduk**.



DIGITAL EDITION

DO NOT ADJUST YOUR IPAD

If last month's "Buy this or be hacked" print cover didn't spook you, then hopefully the iPad version did. Our animation aimed to give the impression that your device was being hacked in front of your eyes; if you didn't get that sinking feeling when the screen went blank, then we have failed... Download WIRED's digital issue to read our security special, plus extended stories and videos, at **wired.co.uk/subscriptions**

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TECH'S EASTERN DREAM

This month, wired.co.uk travelled to Cyberjaya, Malaysia's ill-fated attempt to jump on the digital bandwagon. Two decades ago, billions of dollars were pumped into creating a tech powerhouse to rival Silicon Valley (*an artist's impression is pictured above*). The dream didn't pan out – WIRED's taxi driver hadn't even heard of Cyberjaya – but the city now has plans to reboot itself as a home for innovation, rather than call centres. **Read more on wired.co.uk**

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VINCENT FOURNIER

Fournier travels to the US to photograph the start of the robot uprising – albeit a mundane one. "I placed the robots in realistic reconstructions of typical domestic scenes," he explains. "I wanted to suggest both empathy and detachment toward them."



JULIE HANNA

Hanna, executive chair of micro-loan firm Kiva, heads up our profit-and-purpose report, looking at how young people are forcing businesses to change. "Nine out of ten millennials believe success should be measured by more than financial performance," she says.



PATRICK DIXON

The author of *The Future of Almost Everything* argues in Ideas Bank that the world isn't changing as fast as we think: "There will always be disruptions and economic crises, and we should take them seriously, but history shows that they are often over-played."



PERRY CHEN

Chen, the co-founder and chair of Kickstarter, reveals how becoming a benefit corporation ensures his firm's commitment to doing good: "It lets us be clear that the pursuit of profit will not override our mission. Profit maximisation is not a mantra that we subscribe to."



HELEN PEARSON

The Life Project's author highlights the importance of long-term studies of children. "The first of these started in 1946," she says. "In later decades, these studies revealed links between things such as smoking during pregnancy and infant mortality."

MAKING WIRED



NYC CO-LIVING

WIRED's associate editor, Rowland Manthorpe, headed to New York to shack up with the tech superstars of tomorrow in a co-living habitat: "On my first night at Pure House in Brooklyn, I was drafted into a 'mindful recreational improv' session. I thought, 'What have I let myself in for?'" says Manthorpe. "But the residents' passion for living in a new way convinced me this is a real movement." New York-based photographer, Brian Finke, who shot the feature, agrees. "We were welcomed with hugs and kisses, the party had just started," he says. "After shooting in apartment 212 we went to check out the other rooms. Walking down the halls, all the doors were open and lots of impromptu gatherings were taking place."



BEHIND THE COVER

Photographer Chris Crisman shot littleBits founder Ayah Bdeir for our cover, high on the Manhattan rooftop of the firm's HQ: "It was a blast shooting with Ayah – literally. We'd been hoping for a sunny day with no wind, but that wasn't to be. She was a total trooper, though, and we got some amazing shots of her. You'd never guess she was battling chilly, 30kph gusts coming from the Hudson River."

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LIFE IS A BEAUTIFUL SPORT
LACOSTE

This edition was born in a New York conference room packed with financially successful startup founders brought together by Founders Forum. After intense panel discussions covering exit strategies, growth-revenue metrics and unicorn valuations, Yancey Strickler, a co-founder of Kickstarter, took to the stage to offer an alternative world view. "We will never sell our company," Strickler told the assembled A-list of founders, investors and M&A specialists. "Congratulations to those of you that do, but fuck that."

Ayah Bdeir, littleBits founder and CEO, pictured in New York



Kickstarter had just turned itself into a public benefit corporation, committed to upholding ethical and values-led goals while pursuing profit. The more time I spent with Strickler, the more I began to understand that rising profits at a business like his were not in spite of its mission-driven approach – to some extent, they were because of it. A dinner conversation with Julie Hanna, executive chair of micro-loans marketplace Kiva and an investor in success stories such as Lyft and Lending Club, then clarified why purpose-driven businesses have a clear advantage. Why was so much smart tech talent wasting time building yet another laundry app, Hanna wondered, when it could be put towards solving real problems at scale – and in the process building long-lasting companies whose very purpose serves to attract world-class staff?

This month we meet businesses ranging from Patagonia to Pigeonly that have a meaningful social or environmental mission at their core – which in itself helps build market value. As Ayah Bdeir of littleBits points out, building a business with a social goal (in her case, to let anyone be an inventor) is wholly compatible with a focus on profit: "Making money is very important," she says. "Money is freedom for a company." But purpose is what brings Google employees to take pay cuts to join, and what boosts morale during a startup's stress points. If a company optimises for both, Bdeir says, "It feeds your head, your heart and your pocket. There's no better way to live your life." No wonder the WIRED team have been feeling particularly uplifted while preparing this edition.

As part of our own mission to showcase the people who we know will excite you, we are finalising our plans for our fourth WIRED Money conference in London on June 23 (wiredevent.co.uk). And here, yet again, it's the purpose-driven founders who seem to be winning. From companies bringing transparency to insurance to entrepreneurs using tech to re-invent the usurious money-transfer industry, we see real value being created. And not just value measured in pounds.

FROM THE EDITOR



David Rowan

DMA MAGAZINE OF THE YEAR 2015 • DMA COVER OF THE YEAR 2015 • DMA TECHNOLOGY MAGAZINE OF THE YEAR 2015 • DMA MAGAZINE OF THE YEAR 2014 • BSME ART DIRECTOR OF THE YEAR, CONSUMER 2013 • PPA MEDIA BRAND OF THE YEAR, CONSUMER 2013 • DMA TECHNOLOGY MAGAZINE OF THE YEAR 2012 • DMA EDITOR OF THE YEAR 2012 • BSME EDITOR OF THE YEAR, SPECIAL INTEREST 2012 • D&AD AWARD: COVERS 2012 • DMA EDITOR OF THE YEAR 2011 • DMA MAGAZINE OF THE YEAR 2011 • DMA TECHNOLOGY MAGAZINE OF THE YEAR 2011 • BSME ART DIRECTOR OF THE YEAR, CONSUMER 2011 • D&AD AWARD: ENTIRE MAGAZINE 2011 • D&AD AWARD: COVERS 2010 • MAGGIES TECHNOLOGY COVER 2010 • PPA DESIGNER OF THE YEAR, CONSUMER 2010 • BSME LAUNCH OF THE YEAR 2009

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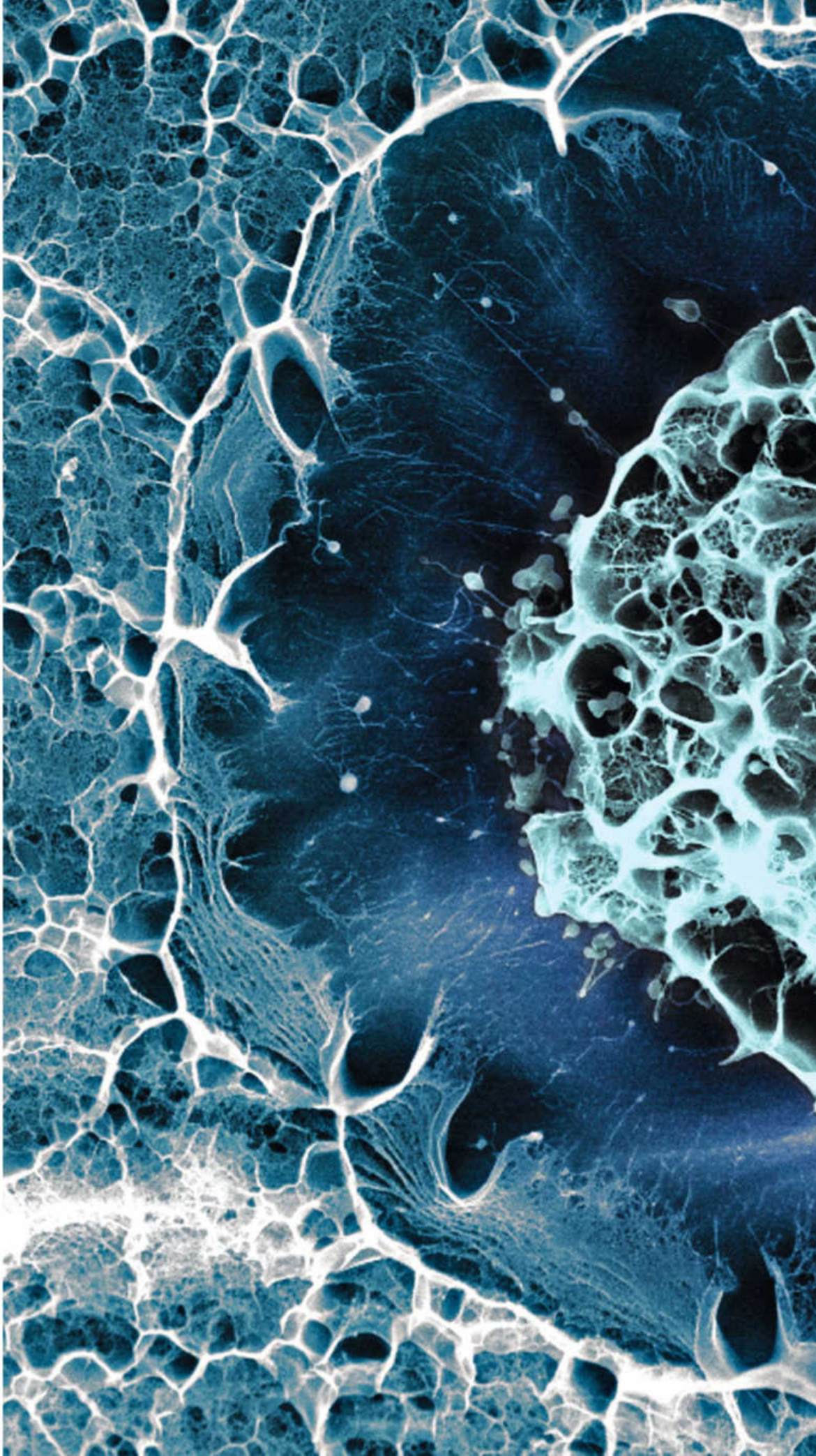
STILL LIFE OF A FROZEN STEM CELL

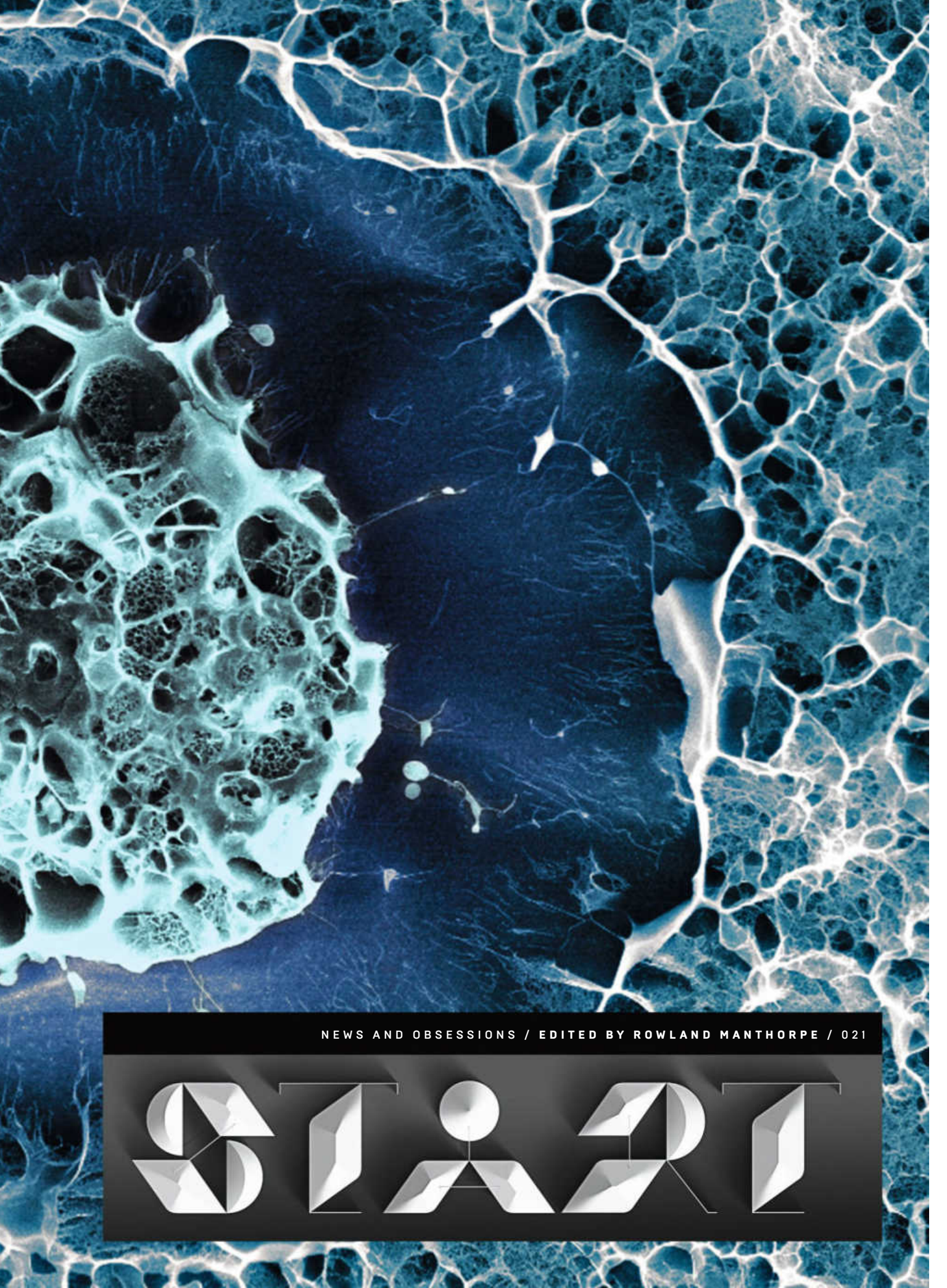
This isn't an alien's eyeball, but a 15-micron-wide stem cell taken from human hip bone marrow. Silvia A Ferreira, Cristina Lopo and Eileen Gentleman, a stem biology research team at King's College London, produced this photograph using cryogenic scanning electron microscopy. "We put the cells in hydrogel and then tried to modulate the properties of this material to mimic the natural environment of the cell," says Gentleman, 37.

The sample contained 500,000 cells packed into a 5mm square cube. It was frozen very quickly at around -150°C – the point at which cryogenics begins – then broken in half, so that cells could be observed on the broken surface. "It's the only method that allows us to see both the cell and its environment," says Gentleman. "This one just happened to break right where we could see the cell and the material around it."

The group's aim, Gentleman explains, is to determine how a stem cell can be influenced by its surroundings. By modifying the local environment, they can select what kind of cell it will end up developing into – for instance, a bone, cartilage or fat cell – to regrow a certain tissue. **Pauline Bock**
wellcomeimage awards.org

Human Stem Cell **was a winner in the Wellcome Image Awards 2016**





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PAY PEANUTS, GET PEANUTS, SAVE LIVES

Chamutal Eitam's charity is using startup efficiency to send children emergency nutrition



3 Million Club CEO Chamutal Eitam: "It's about not bombarding people with bureaucracy"

HERE'S A FOODSTUFF THAT'S SO nutritious it can bring a starving child back from the brink of death. Made from fortified peanut paste mixed with dried skimmed milk, vitamins and minerals, Ready-to-use Therapeutic Food (RUTF) is "an amazing product", says Chamutal Eitam, CEO of the 3 Million Club charity. "A child that can hardly walk or stand up eats it, and after between three and 12 weeks they can run and play football. And they look like a child, whereas before they looked like a skeleton."

3 Million Club enables donors to buy packets of RUTF to send to Haiti, where five per cent of children suffer from acute malnutrition, according to the World Food Programme. Using the charity's website, donors can buy boxes of the foodstuff from local factories and send them to grass-roots aid agencies. The box is tracked by its barcode, so the donor knows how their money – $5 (£3.53) buys ten bars, one week of RUTF treatment – is being used. "It helps you understand what you are supporting," says Eitam, 37, who worked for the United Nations and Norwegian People's Aid before joining 3 Million Club. When WIRED used the service, it watched its bars go to the Real Hope for Haiti clinic, where they fed 37 children.

3 Million Club is modelled on e-commerce firms such as Amazon, and Tel Aviv-based Eitam contrasts its "startup efficiency" with the mechanics of "middle-man" charities such as Unicef or Save the Children, which, she says, take donations then "hire a local partner to do the work". Save the Children's admin costs mean that "if you donate a dollar now only 0.14 cents will get to the child." By contrast, Eitam claims that 3 Million Club ensures "ninety-eight per cent of what you give buys the product, the rest goes on transport".

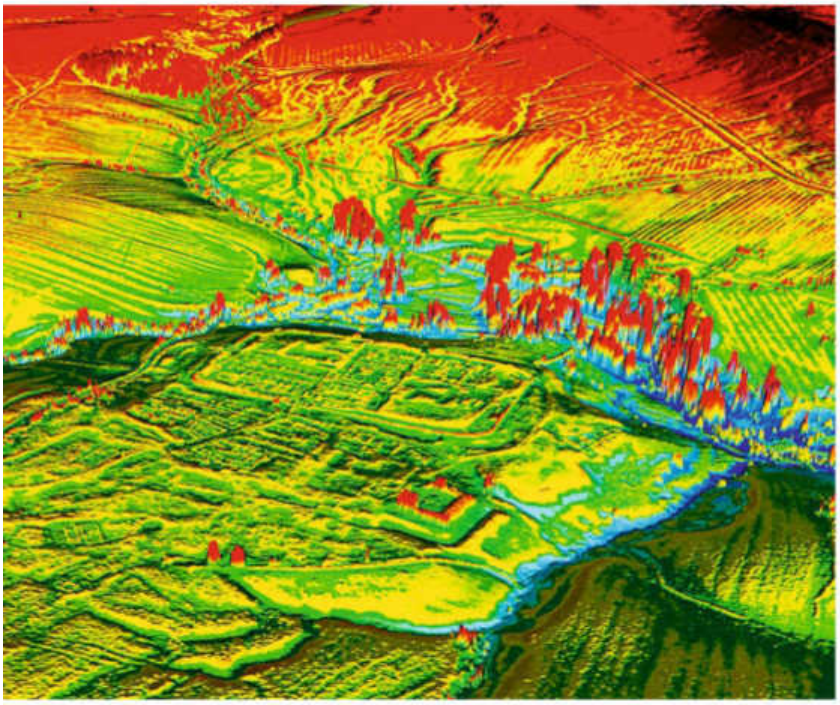
Eitam hopes to expand the two-person operation to get "more product in the platform". "We're not saying it's suitable for all humanitarian aid but it works for emergencies where a physical product needs to be delivered to people on the ground," she says. **RM** *3millionclub.com*

212,750

RUTF bars have been delivered, saving 1,850 lives in Haiti, Nepal and India



PHOTOGRAPHY: DAVID STEWART



STREET VIEW FOR ROMANS

Want to discover buried ancient roads? Use a laser

The horizontal line wending its way across the middle of this image is a 2,000-year-old Roman road. It was recently detected by David Ratledge, an amateur archaelogist, using Environment Agency data gathered by laser scans – in this case, of the remains of the ancient settlement of Vindolanda in Northumberland. The agency uses Light Detection and Ranging (LiDAR) to scan the British landscape, then puts the measurements on to its geostore.com site. Using the data – and some open-source geographic software which turns lists of terrain heights into 3D maps like the one on the left – Ratledge spotted the buried road. "What you're looking for is a long, straight line or ridge," says Ratledge. "If it goes across many fields, you've probably got a Roman road." The trick, he says, is not to confuse them with pipelines.

When Ratledge spots something on his 3D map, he looks for clues "such as small bridges where the road would have crossed a stream". Ratledge has found seven portions of roads and a full one that goes from Lancaster to Ribchester. Before LiDAR, Ratledge, who has been searching for 45 years, would "look for bumps in the field on aerial photographs". **PB**

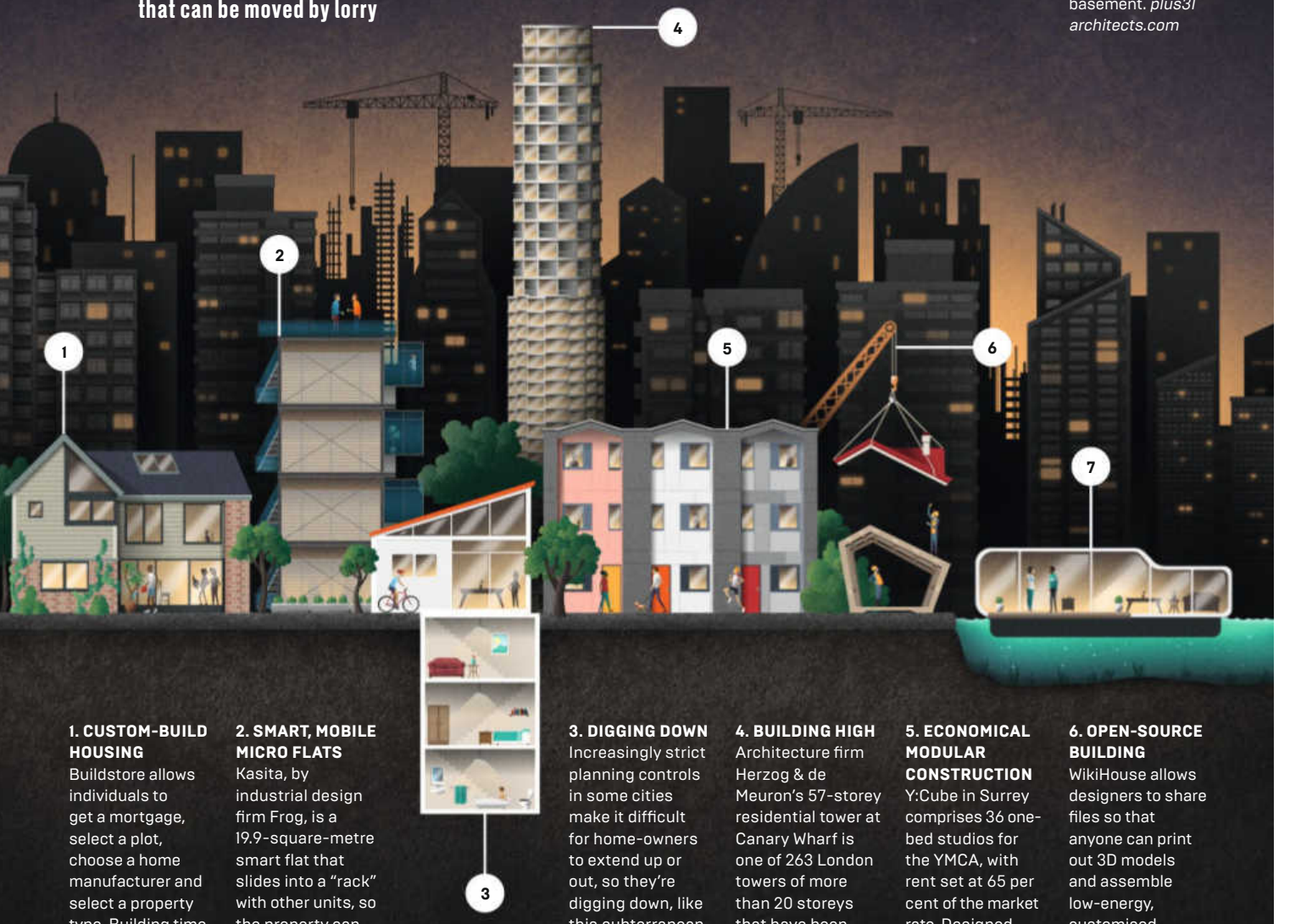
romanroads.org

WIRED	TIRED	EXPIRED
T'Challa	**T'Pau**	T'Pol
The Slacklash	Backslashes	**Slashdot**
AI Cards Against Humanity	**DeepMind Go**	*Deep Blue* chess
Dr Pimple Popper	PewDiePie	**Oolong the rabbit**
CoyoteVest	**Thundershirts**	Doggles
IBM Watson	@DeepDrumpf	**Marco Rubio**

WIRED SOLVES THE HOUSING CRISIS

Build up, dig down and make flats that can be moved by lorry

YOU MAY HAVE NOTICED: CITIES ARE SUFFERING FROM A housing shortage. "In Europe, volume house-builders roll out hectares of mediocre boxes," says Peter Murray, chairman of New London Architecture. These standard house types are often too expensive or unsuitable for buyers, and on large sites of more than 250 plots are built very slowly. But standard designs are being challenged by self-build initiatives and co-operative housing schemes, which are quicker and often cheaper to construct, and give the homeowner more control. "New technologies will create more sophisticated self-build systems, while also allowing the larger manufacturers of houses to create more bespoke and tailor-made solutions," says Murray. Here's how WIRED would solve the problem. **Clare Dowdy**



1. CUSTOM-BUILD HOUSING
Buildstore allows individuals to get a mortgage, select a plot, choose a home manufacturer and select a property type. Building time is 12 to 24 weeks and the sales rate is five times faster than for standard houses, because people have had a say in their home design. The Dutch city of Almere is undertaking an experiment in custom-build, and is planning 3,000 units. *custombuild homes.co.uk*

2. SMART, MOBILE MICRO FLATS
Kasita, by industrial design firm Frog, is a 19.9-square-metre smart flat that slides into a "rack" with other units, so the property can be mobile. The first Kasitas, which cost $89,999 (£63,790), are due to arrive in Austin, Texas, later in 2016, and will be installed on unused sites that can't be conventionally developed. *kasita.com*

3. DIGGING DOWN
Increasingly strict planning controls in some cities make it difficult for home-owners to extend up or out, so they're digging down, like this subterranean extension in Fulham by Shape Architecture. Once property values exceed £10,800 per square metre, building a subterranean living space becomes a no-brainer. In London, it costs £3,500 per square metre to build a basement.

4. BUILDING HIGH
Architecture firm Herzog & de Meuron's 57-storey residential tower at Canary Wharf is one of 263 London towers of more than 20 storeys that have been granted approval, are under construction or are built. Eighty-one per cent of those are residential, because building up is believed to improve population density. *herzog demeuron.com*

5. ECONOMICAL MODULAR CONSTRUCTION
Y:Cube in Surrey comprises 36 one-bed studios for the YMCA, with rent set at 65 per cent of the market rate. Designed by Rogers Stirk Harbour + Partners, the 26-square-metre-units are factory-built and stackable, each taking only two weeks to build, so it can be adapted to urban sites. *rsh-p.com/projects/ycube*

6. OPEN-SOURCE BUILDING
WikiHouse allows designers to share files so that anyone can print out 3D models and assemble low-energy, customised homes. The parts are digitally manufactured, with cutting and build time totalling around six weeks. It eliminates architect fees and because much of the kit is prefabricated it is quicker to build than standard housing. *wikihouse.cc*

7. FLOATING HOMES
When land is scarce, why not exploit urban rivers, seafronts, and canals? +31Architects' Watervilla Weesperzijde houseboat, designed for a client, sits on Amsterdam's River Amstel and has bedrooms in the basement. *plus31 architects.com*

ILLUSTRATION: MUTI

THE AI WILL SEE YOU NOW

Sophia Genetics wants to give cancer patients a faster, more accurate diagnosis



Jurgi Camblong (*left*) plans to work with "liquid biopsies" making the process less invasive and faster

JURGI CAMBLONG IS DIAGNOSING cancer using thousands of people's DNA. The 38-year-old Sophia Genetics co-founder detects cancer in the lungs, skin, ovaries and breast, as well as congenital diseases, by sequencing the genomes of patient's tissue samples – then uses machine learning to compare the results and suggest the most effective treatments.

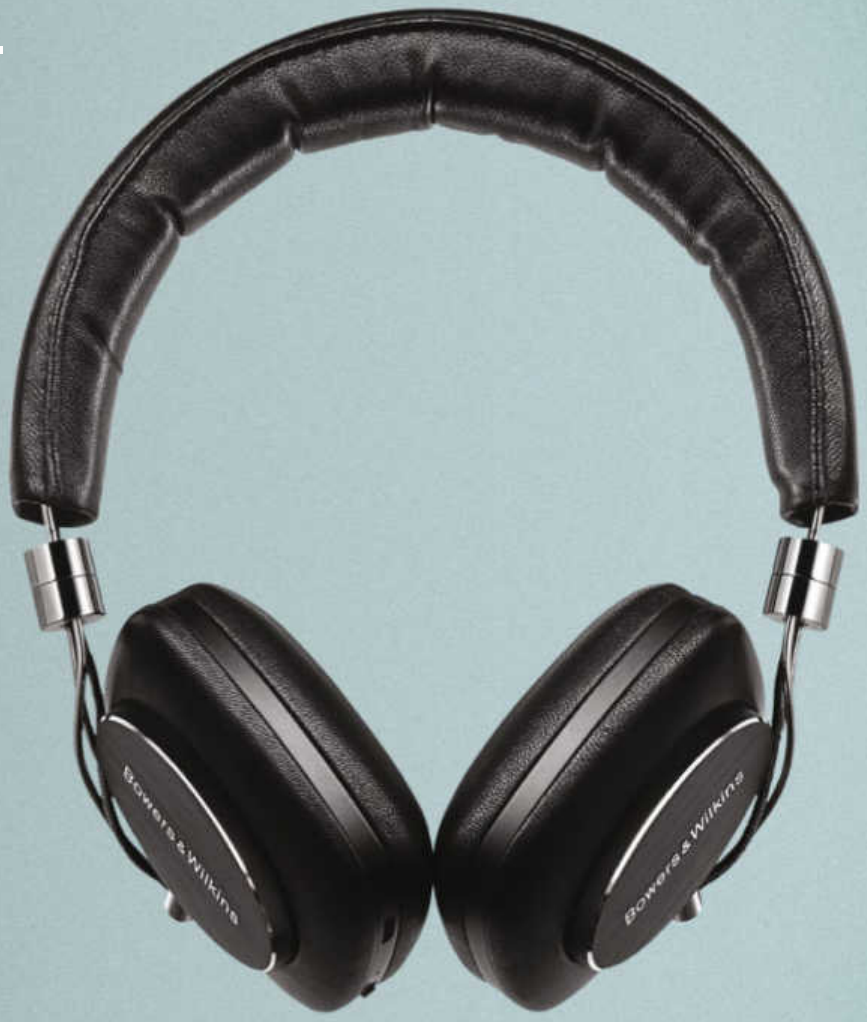
"The problem is not producing the content or the data but really analysing to find the important information so you can act on a disease," says Camblong. Sophia Genetics's machine learning system, created in 2011, is used in more than 100 hospitals across 20 European countries, including Oxford University's John Radcliffe Hospital and Liverpool Women's NHS Foundation Trust. Hospitals pay each time they use the tool. In its first 18 months, the company was involved in the diagnosis of 25,000 patients. In 2016, it aims to make 80,000 diagnoses. Once the startup, which has raised more than £20 million from investors including Mike Lynch, receives patient data from a hospital, it can find genes related to diseases, such as BRCA-1 in breast cancer, within two hours.

Genetic sequencing and treatment is being tackled by some of the world's biggest organisations: Google and Amazon both help scientists analyse genetic data, and the NHS is sequencing 100,000 genomes from 70,000 people. Camblong says 60-person Sophia Genetics' advantage is that it can compare patient data across hospitals. "Algorithms recognise the context in which this raw data has been produced, eliminate biases, and make the results comparable," he says.

The company is monitoring the success of each treatment. "In two years time we could [from your genotype] tell you that your cancer looks like the cancer of 1,000 other patients, 500 received that drug and 80 per cent survived," says Camblong. It's not the cure – but it's a better diagnosis. **Matt Burgess** *sophiagenetics.com*

PHOTOGRAPHY: SANDRO BAEBLER

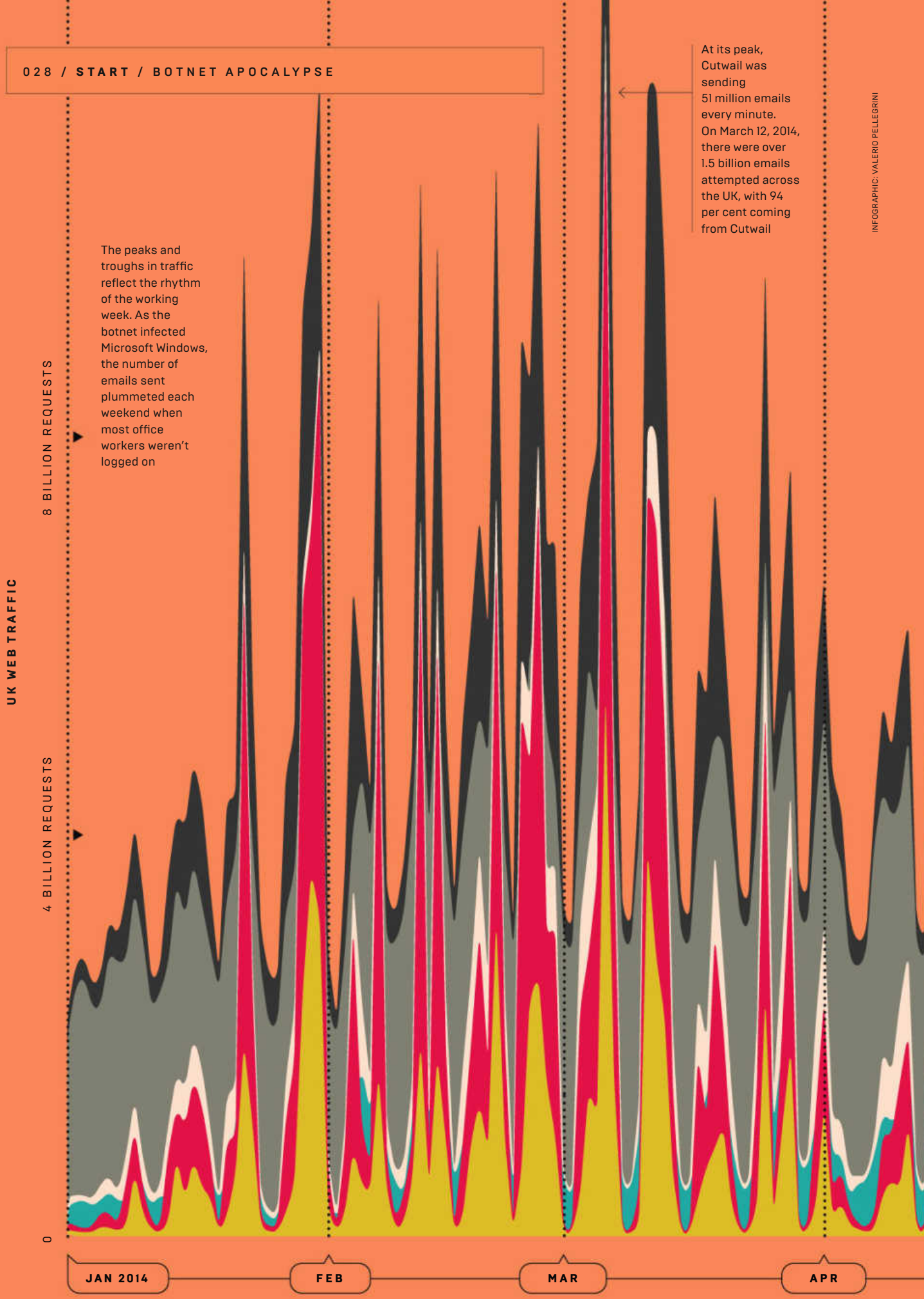
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INFOGRAPHIC: VALERIO PELLEGRINI

THE RISE AND FALL OF THE UK'S BIGGEST SPAMMER

IN 2015, AROUND 60 PER CENT OF ALL EMAILS IN THE WORLD WERE SPAM. But a spam campaign is only as good as its data. If the emails aren't being opened, or are sent to addresses that no longer exist, then the scam fails. That's why you need a good botnet.

At its height, the Cutwail botnet, created by Russian hackers around 2007, was responsible for nearly half the world's spam, and had a network of two million infected computers sending 74 billion emails a day (8bn to the UK alone) from computers running Microsoft Windows.

Nominet, the UK's domain registry, has been monitoring the behaviour of Cutwail for years. "We see patterns in the traffic going in and out of our name-server infrastructure," says Nominet researcher Siôn Lloyd. "We can also see how much of our traffic is 'legitimate'."

Using its Turing data analysis system, Nominet was able to get to grips with how the botnet was behaving. "We have ways of visualising the data that makes these flaws stand out," says Lloyd. "Once we know what we're looking for we can isolate them completely."

By 2013, Cutwail had became the go-to method for sending spam, spreading alongside the Gameover ZeuS Trojan and CryptoLocker malware. Then, in May 2014, the FBI and other law enforcement agencies, including Europol, decided to shut it down.

The effect was almost immediate. Cutwail's scale collapsed, but so did its ability to send effective spam emails. As the lists of addresses it relied on went out of date, the hampered botnet slowed to a whimper. It still exists today, but Cutwail spam is far less likely to reach your inbox. WIRED tracks its rise and fall. **James Temperton** *nominet.uk*

KEY

WEB TRAFFIC
Requests made to the servers responsible for ".uk"

GOOD WEB TRAFFIC
Requests that can be answered (for example, ones for a .uk domain that exists)

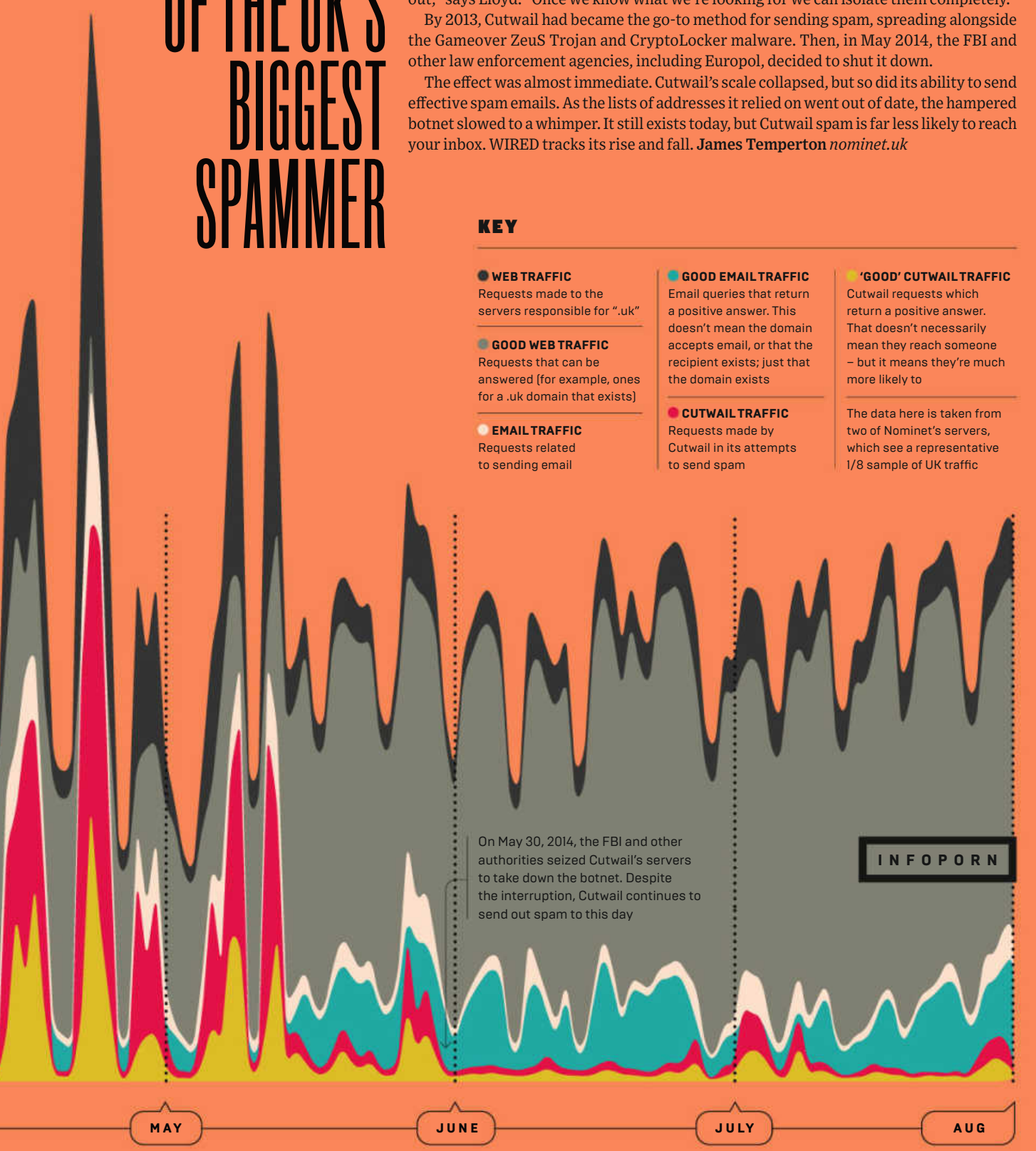
EMAIL TRAFFIC
Requests related to sending email

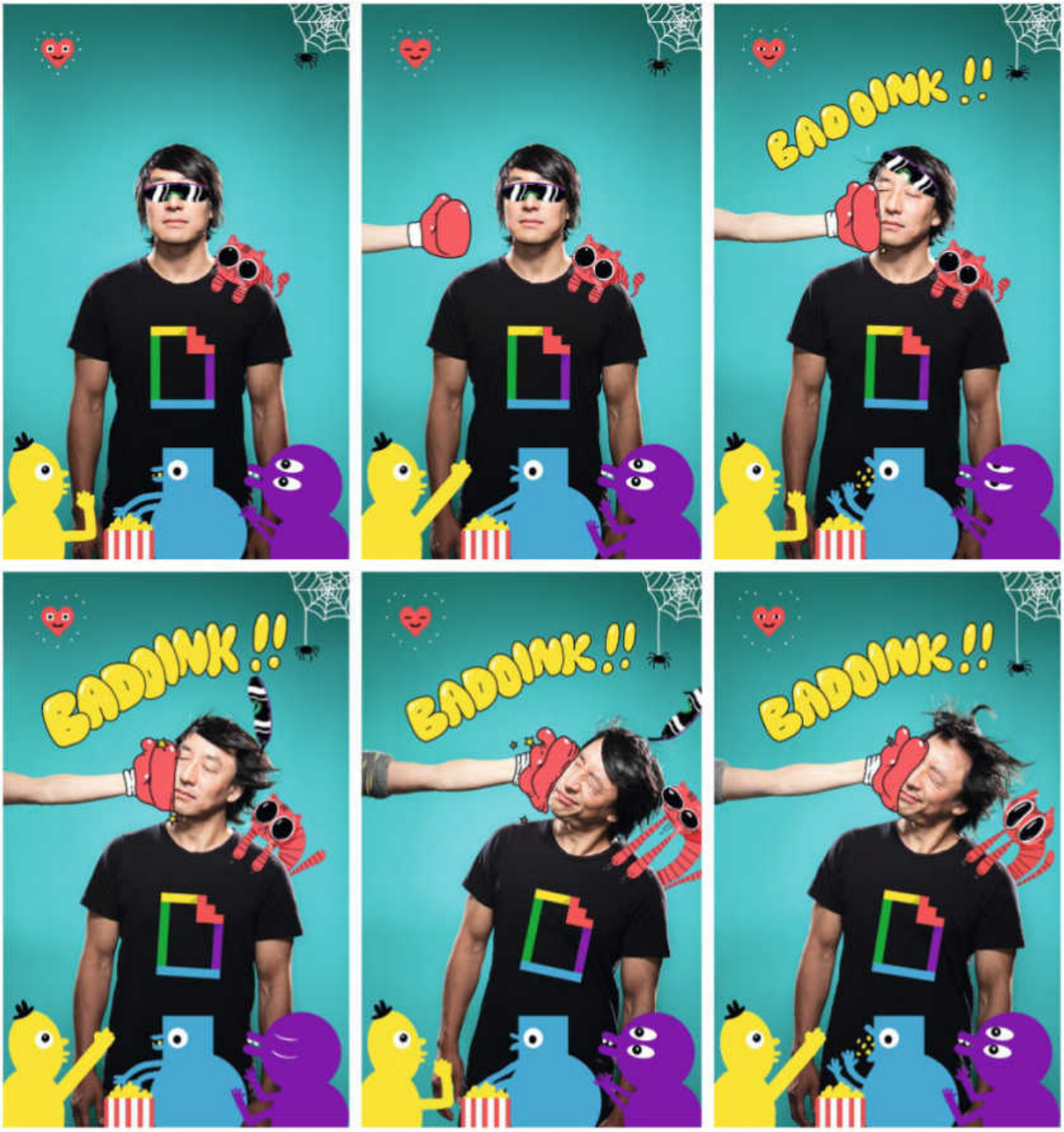
GOOD EMAIL TRAFFIC
Email queries that return a positive answer. This doesn't mean the domain accepts email, or that the recipient exists; just that the domain exists

CUTWAIL TRAFFIC
Requests made by Cutwail in its attempts to send spam

'GOOD' CUTWAIL TRAFFIC
Cutwail requests which return a positive answer. That doesn't necessarily mean they reach someone – but it means they're much more likely to

The data here is taken from two of Nominet's servers, which see a representative 1/8 sample of UK traffic





INSIDE GIPHY'S INFINITE LOOP

Alex Chung has taken the art of the clip and turned it into a $300 million animated empire

When you're CEO of a GIF firm, it's hard to be taken seriously – even if that firm is the biggest animated-clip search engine in the world. "When I say I work for this GIF company, they're like, 'What do you have, two guys?'," explains Alex Chung.

But in a typical month, Giphy, the 42-person GIF repository Chung set up in February 2013, receives more than 100 million unique monthly visitors; over four billion hits from its API; and serves more than 25 billion GIFs. Last winter it talked to Facebook about acquisition, but then went on to raise $17 million (£12m), followed by another $55m in February at a valuation of $300 million. "We grew 100 times the first year, and another 20 times the next year. We grew five times this year," says Chung, 40. He gives a giggle. "It's kind of funny."

Alex Chung, CEO of Giphy: "The first step was to own the GIF. It's the same thing SoundCloud did with online music, that YouTube did with video"

G

iphy – that's a hard "G", internet pedants – began life as a web crawler that found and ranked every moving .gif file on the internet. (There are currently around 150 million original GIFs, according to Giphy's analysis.) When Chung created it, he was taking time out, disenchanted with startup life after years in the business, including spells making hardware for Intel and software for MTV. One evening, he was discussing the limitations of language with his friend Jace Cooke, 34. Moving images were so much more expressive than printed words – so, as an experiment, Chung decided to build a search engine to find them. Within a week his "Google for GIFs" had 30,000 page views and Chung and Cooke had an investment offer of $1 million from Betaworks, one of the original funders of Kickstarter. "It was like being an artist, and you do some sketches and someone's like, 'Here's a million dollars, go do more of this'," says Chung.

What do you do when you're making GIFS your business? "The first step was to own the GIF," says Chung. "It's the same thing that SoundCloud did with online music, that YouTube did with video." Other GIF startups – the list, as you'd expect, is long – always come second to Giphy on search engines, says Chung. What's more, Giphy has been able to arrange licensing agreements with major content providers, meaning it's much less likely to get sued by angry movie studios for breach of copyright. "We invented GIF licensing," says Chung. "We barely get any DMCAs [takedown requests]."

Giphy's next move was to take control of distribution by arranging partnerships with key mobile platforms and messaging services. Giphy is now integrated into Slack, Facebook *Messenger*, iMessage and, most recently, *Tinder*, where a button in the app's chat function lets users flirt via GIF. Giphy also has a studio that works with brands and broadcasters to create new GIFs for big releases, such as *Star Wars: The Force Awakens* or the return of *The X-Files*. The resulting combination of distribution and content is strangely reminiscent of a traditional publisher or broadcaster. "We're a GIF media company," says Chung.

Giphy doesn't make any revenue yet, but Chung paints a vision of a future in which people go to Giphy for real-time news, and search engines provide animated results instead of bland lists of links. When GIFs are this popular, anything seems possible. "We have this side project called Giphy TV," says Chung, "and this does 300 million views a month, as some random thing. It's the new way of browsing TV – you don't want to watch the shows, you just want to watch the highlights. That could be an entire cable network." A TV channel for cats and "Hotline Bling" memes? "When MTV launched, everyone laughed, saying 'No one's going to watch two-minute music videos'," he says. "Now they're making the same argument about GIFs." **RM** *giphy.com*

PHOTOGRAPHY: HOLLENDERX2

APPS OF THE MONTH



WIRED

MIMICKER ALARM

Snoozing is impossible with this sadistic alarm clock, which makes you play games to prove you are awake. The default puzzle is to take a selfie while pulling a face. Built by Microsoft's Garage Team – using APIs from UK-based Project Oxford – the app's facial recognition software detects your expression. *Android, free projectoxford.ai*



KOKO

Got a worry? Post your qualms on *Koko* and turn to the kindness of strangers for support. Users write the worst-case outcome of their fear and receive advice on re-framing it in the manner of positive psychology. The best inspirational links and messages are upvoted to show at the top of the feed. *iOS, free itskoko.com*



FLOWSTATE

This note-taking tool ensures total concentration from writers by deleting every word they've written if their fingers leave the keyboard for more than seven seconds. With this looming threat, Flowstate helps people get in the "flow", and resist the distractions popping up elsewhere. *iOS, £7.99 hailoverman.com*



THE PICKLE INDEX

The ten-part story of a circus troupe attempting to break their ringmaster out of prison, *The Pickle Exchange* uses mini-games and a recipe network to tell a tale of life under a surreal, fermented-goods-based dictatorship. Clunky functionality and a difficult narrative are part of the (literary) point. *iOS, £3.99 thepickleindex.com*



HEY! VINA

"The *Tinder* of..." has become a well-worn phrase in tech circles, but *Hey! VINA* can lay claim to being the *Tinder* of female friendship. Peripatetic women swipe through potential friends' profiles to find their perfect companion from people matched on similar personalities and hobbies. *iOS, free heyvina.com*



WEIRD

FOLLOWER

Followers are the currency of social networks – but what if a stranger actually followed you around? This app grants you a real-life follower for the day, who watches you from afar. Successful applicants will be notified the morning they're about to be stalked by a human shadow. *iOS, free follower.today* **Alex Jordan**

D5500

24.2 MEGAPIXEL

VARI-ANGLE TOUCH SCREEN

39 FOCUS POINTS

BUILT-IN WIFI



I AM READY TO IMPRESS

I AM THE NIKON D5500. Photographer Andrius Aleksandravičius expresses the full potential of his creativity – and so can you. Turn your ideas into great images with the advanced technology of the D5500. The new vari-angle touchscreen, built-in Wi-Fi* and exceptionally portable and easy-to-handle body make it your smart companion for every project. With a 24.2 MP sensor, 39 focus points and an ISO range up to 25,600, the D5500 always gives you superior image quality. Get inspired and take your photography to the next level with the D5500.

*Wi-Fi enabled smart device is required to share images.



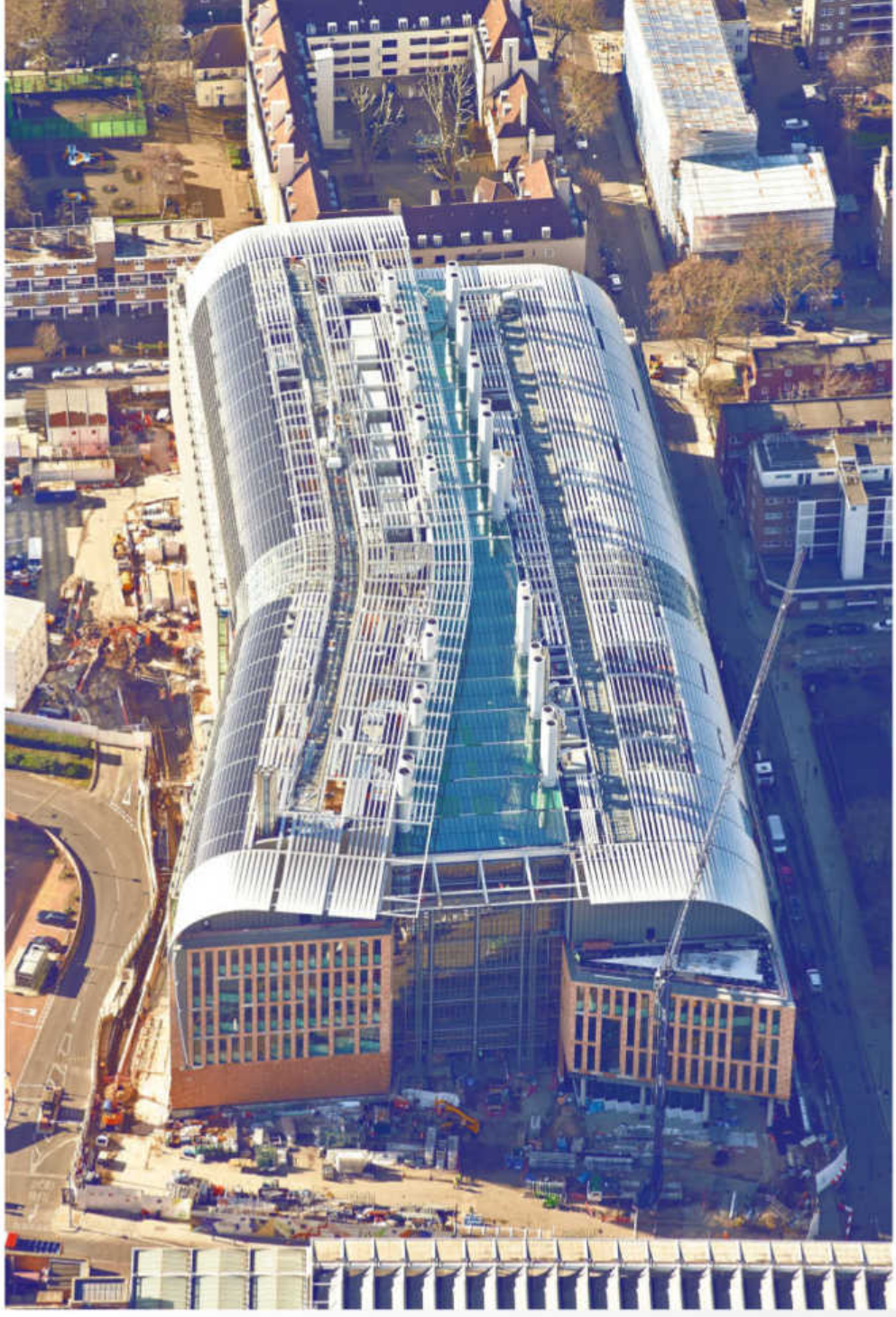
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At the heart of the image



PHOTOGRAPHY: LAING O'ROURKE

WHERE SCIENCE GETS SHAKEN UP

London's Francis Crick Institute is designed to promote serendipitous interactions between divergent researchers

HOW TO GET MINDS TO MEET
The Crick occupies four laboratory "neighbourhoods", linked by two atria holding all the social areas, forcing scientists to mingle.

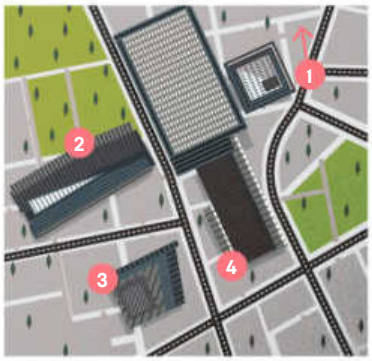
HOW DO YOU DESIGN A BUILDING THAT PROMOTES CROSS-disciplinary science? "You build one that's big enough," says Sir Paul Nurse, director of the Francis Crick Institute, due to open at the end of the year. This biomedical research institute – the biggest in Europe – will welcome 1,250 researchers from six institutions to study cancer, neurodegenerative conditions and infectious diseases. With 1,553 rooms and a floor area of nearly 93,000m^2, the challenge for the Crick isn't just to bring them under the same roof; it's how to make them work together. "The whole building is designed specifically to encourage people to interact," says Jim Smith, director of research.

To avoid the "silo effect", the Crick has no departments – instead, researchers from divergent fields have been allocated labs in what Nurse calls "gentle anarchy". (As a study progresses, scientists will be moved into different "interest groups".) Team leaders' offices are too small to hold big meetings – so these will take place in >

a collaboration space. The labs, each with rooms for tissue culturing, instruments and microscopes, are arranged to accommodate teams of up to a dozen scientists. "We intentionally placed groups from different disciplines next to each other," says Nurse, 67. Although chemists' need for specialised equipment meant they had to be clustered.

On the Crick's ground floor, a 450-seat auditorium and exhibition space sit next to a cafeteria that holds 450 people. To achieve this, Nurse had to overrule Camden Council, which wanted staff from the facility to patronise local restaurants. "The canteen was crucial," Nurse explains. "Francis Crick, the biophysicist who revealed the genetic code in 1953, was an advocate of discussing scientific ideas over food and drink. He believed the best collaborative ideas arose during informal moments." The room was designed to be just small enough to force scientists to sit together during lunch, rather than seek out solo tables. Developed by London-based architects HOK and PLP, the building, situated next to the British Library and the Alan Turing Institute in Euston, is arranged "like a chromosome", says Smith: four interconnected blocks covered by a vaulted roof, with three and a half floors of lab space. To help people get around, the Crick has its own way-finding app.

LONDON'S NEW R&D QUARTER



1. New Google HQ **2.** The Crick Institute **3.** The British Library & Alan Turing Institute **4.** St Pancras International (Google DeepMind is also in this neighbourhood but chooses not to disclose its location)

The Crick Institute's subterranean levels hold four storeys of animal-testing labs and rooms for imaging. One-metre-thick concrete walls with sonic sensors protect the basement's highly vibration-sensitive imaging equipment. The building's deep foundations were dug between a Thameslink station box and Camden Town's gas mains.

Created from the merger of the London Research Institute and the National Institute for Medical Research, the Crick was funded by scientific organisations (the Medical Research Council, the Wellcome Trust and Cancer Research UK) and universities (University College London, Imperial College London and King's College London), which between them invested £650 million. With its estimated annual budget of £130 million, some in the scientific community have expressed concern that the Crick's size makes it impractical. Nurse disagrees. "While the Crick is going to be one of the world's largest research institutes under a single roof, in terms of research groups it is about the size of one of the larger university departments," he says. "You don't hear people say that a university is too big to fail." **PB** *crick.ac.uk*

EARLY ADOPTERS



WHAT'S EXCITING...

JACKIE ALLEN

Digital technician,
Amazon Fashion

"I'm a list person. **Sortd** turns your Gmail inbox into custom, organised lists that allow you to visually stay on top of things without drowning in a sea of cryptic subject lines. It's currently only in private beta for Google Chrome, but will be expanding to other browsers soon. I love the new view so far."



WHAT'S EXCITING...

ARI POPPER

Founder and CEO,
SciFutures

"I am very excited about ***TiltBrush***, a virtual-reality application that lets you paint in 3D space using a head-mounted display and gestural input devices. You can create art in an exciting new dimension that is both visceral in its effect and flexible in terms of how it can be experienced."



WHAT'S EXCITING...

COLIN NAGY

Executive director of media,
The Barbarian Group

"**Hello Alfred** is a tech-enabled butler service that has been organising my life. When I come home, there's always flowers waiting, laundry put away and a sense of care that makes me feel looked after. They treat their employees very well, unlike a lot of the on-demand world."



WHAT'S EXCITING...

MARY LOU JEPSEN

Executive director of engineering,
Facebook/Oculus

"In Hiroshima, I recently drove on a **'melody road'**. It's a road that plays music using varying spaces between grooves in the road. They transmit vibrations through the car's tires, and you hear it as a musical tune. It was the welcome song to the city!"
Pauline Bock

MAP ILLUSTRATION: JAMES BOAST



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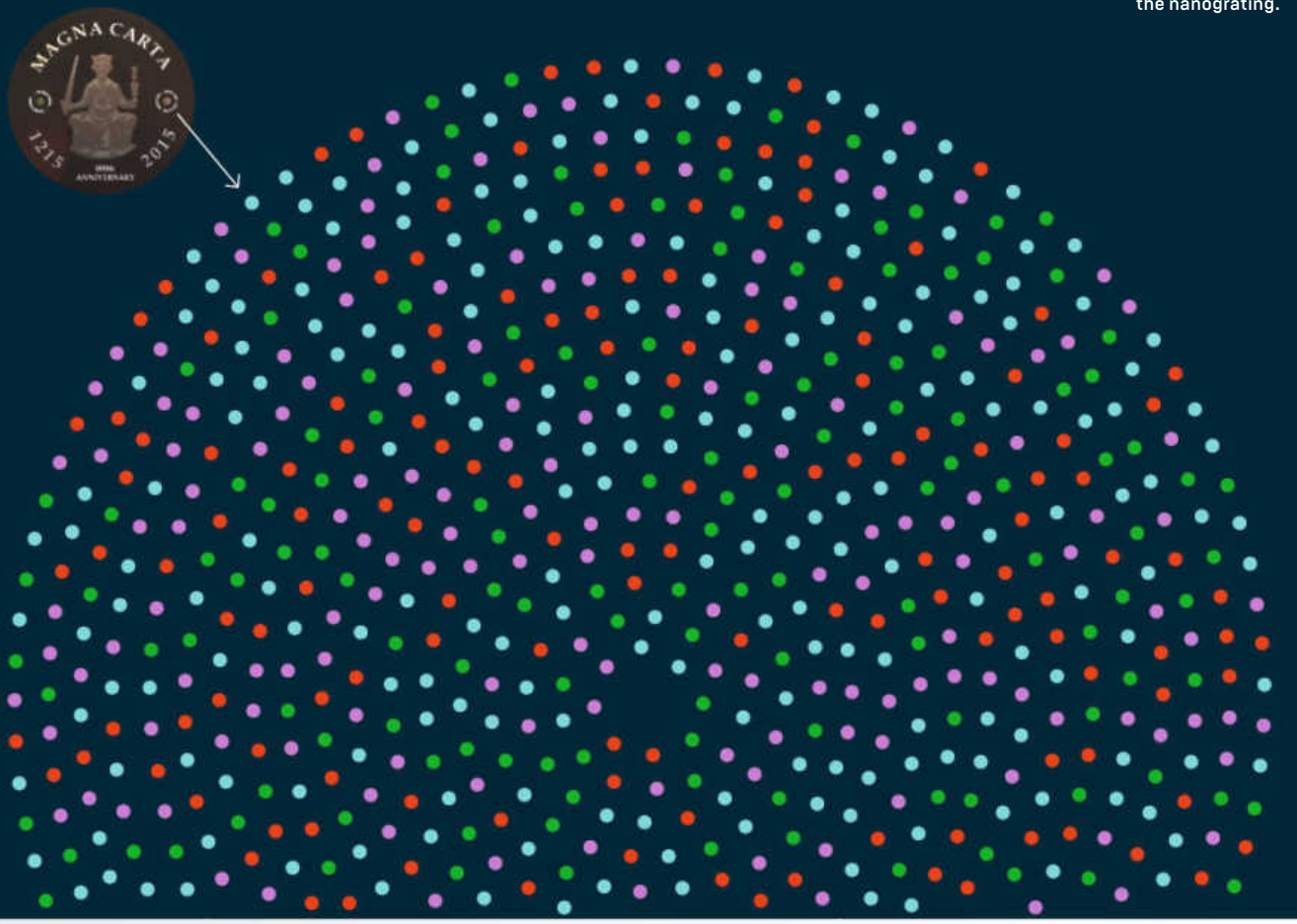
Microsoft Cloud

MAGNA CARTA ON A PINHEAD

5D memory storage packs terabytes of data on to tiny pieces of glass – and (in theory) lasts forever

THE ENGRAVINGS ON THE DISC BELOW CAN WITHSTAND TEMPERATURES OF 1,000°C and should last as long as the Universe has existed. Created by researchers led by Peter Kazansky at the University of Southampton's Optoelectronics Research Centre, the storage, known as 5D optical memory, was developed by laser-writing data on to glass. The team engraves indentations that are ten times more tightly packed than on a Blu-ray disc. "The technique allows storage of data that won't deteriorate," Kazansky explains. The engravings, or nanogratings, have a decay rate that should allow them to last 13.8 billion years.

Each indentation in the nanostructure can hold ten bits, rather than the single bit that standard data-storage devices manage in the same space. To demonstrate these capabilities, the Magna Carta has been etched in its entirety into a circle of 1mm-wide glass. (Kazansky placed it on a wider disc to make it easier to hold.) A CD-sized piece of glass made using the same design can hold 360 terabytes of information. And with the International Data Corporation estimating that 44 trillion gigabytes of information will be generated by 2020, companies have come calling – including Warner Brothers, which enquired about using the technology to archive its huge movie collection. The next step: making sure the format isn't lost down the back of a sofa. **Chris Stokel-Walker** *southampton.ac.uk*



HOW IT'S DONE
A femtosecond laser beam carves data on to glass in a tightly packed nanostructure up to 18 layers thick. The colour of each dot indicates the orientation of the nanograting.



DECOMPOSE RESPONSIBLY

Unless Ray Kurzweil's pills deliver sharpish, we're all going to die. So why not consider one of these greener options for when your time is up? Sophia Epstein

Promession
Swedish biologist Susanne Wiigh-Mäsak can turn cadavers into compost. In promession, the body is frozen using liquid nitrogen, vibrated and then dehydrated. The freeze-dried remains are then turned into soil that makes a nice fertiliser. *promessa.se*

Green cremation
Developed by the Mayo Clinic, green cremation compresses the 25-year disintegration process into a matter of hours. In the $2,400 (£1,700) process the body is boiled and dissolved into a liquid and the remaining bones are ground into dust. *greencremation.com*

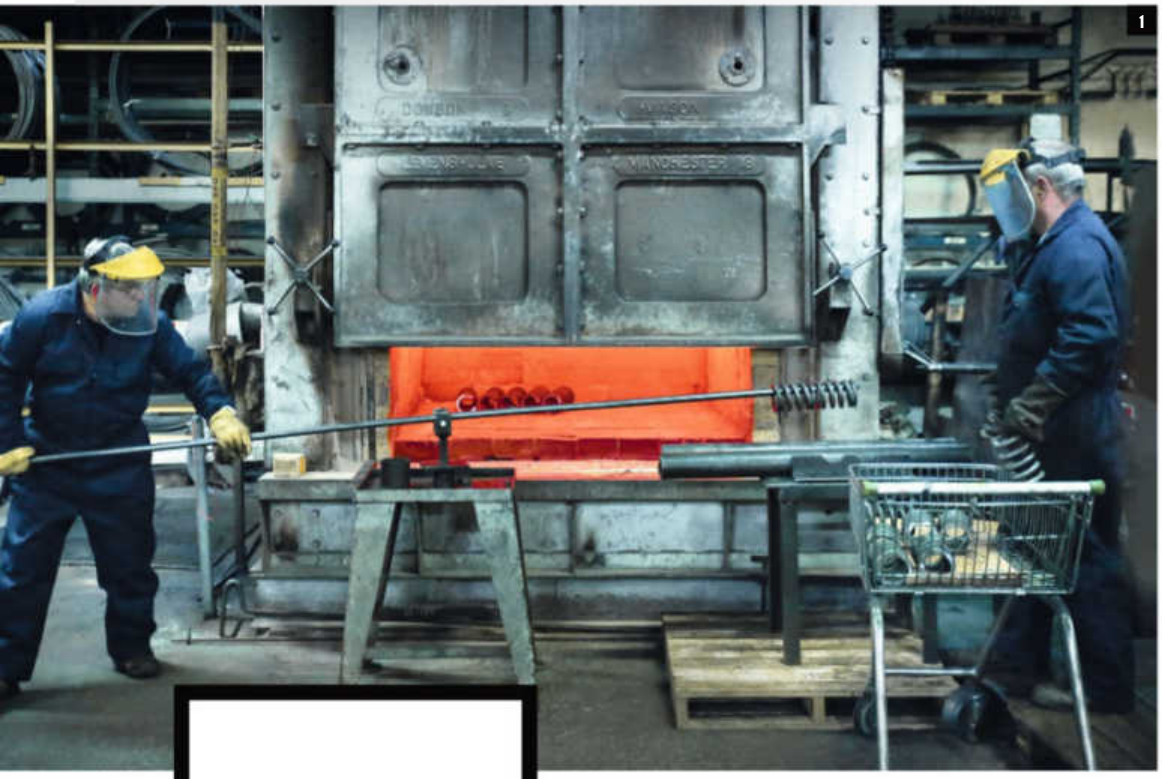
Mushroom death suit
Artist Jae Rhim Lee has designed an outfit that includes spores from a strain of fungus that decomposes the industrial toxins that build up inside us. Dennis White, a 63-year-old with terminal brain disease, has become her first customer. *coeio.com*

ILLUSTRATION: GIOVANNA GIULIANO


This cloud
redefines winning.
The Microsoft Cloud gives Special Olympics instant access to key performance and health data for every athlete, no matter where they are. Microsoft Azure and Office 365 help streamline the management of 94,000 events across 170 countries each year. So the focus can be on changing the lives of athletes, and that's the true victory.
This is the Microsoft Cloud.
learn more at microsoftcloud.com
Microsoft Cloud

THE FIRST DAY OF (A) SPRING

WIRED's series on tools visits the Glasgow birthplace of an essential component



1. FURNACE
To coil a spring safely, Industrial Springs uses a softer material, such as chrome vanadium. It then hardens it for 30 minutes in this 920°C furnace. The temperature is regulated by two gas burners.

TOOLKIT



OU'LL FIND THEM IN MATTRESSES, STAPLERS AND door handles – oh yes, and nuclear reactors. "There's a spring in pretty much every mechanical product," says Stewart Lauder, quality manager of Glasgow-based Industrial Springs. "We manufacture springs that are the thickness of a hair, up to the thickness of your arm."

To make a spring, a coil is placed on to a former, which curves the wire. After that, the top and bottom of the spring are ground to make them flat, so it can sit on a level surface. "They've got to be sitting straight so the generated force is linear," explains Lauder. Next, the springs are heated to 920°C, cooled rapidly in quenching oil, then heated again to 450°C. Then there's painting, packing and finally, transport. Prices vary depending on size, but the springs in these pictures cost around £80,000 for a batch of 2,000.

Competition from China has forced Industrial Springs to shrink from 50 to 12 people since it started in 1964, but demand is still high, although for many, the process remains a mystery. WIRED investigates. **RM** *industrialsprings.com*



2. SPRING COILER
The rollers on the left of this machine straighten the wire, which arrives at the factory in a coil, before the points in the centre form it into a spring shape. This machine is for smaller wire diameters and churns out 1,000 springs an hour. Industrial Springs produces 5,000 of them every day.



3. POWDER COATER
The springs are powder-coated using an electrostatic gun, then cured at 230°C. Here, springs for a shale shaker are emerging from the curing oven. Powder-coating adds a rust-resistant hard finish, but it's also done for appearance. "A lot of customers like the springs to match the machine they're selling," says Lauder.

PHOTOGRAPHY: GORDON BURNISTON


This cloud stands up
to any storm.
Microsoft Azure scales to enable AccuWeather to respond to 10 billion requests for crucial weather data per day. This cloud rises to the challenge when the weather is at its worst.
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Microsoft Cloud

WALK THIS WAY

SuitX's accessible step-aiding frame is inspired by human gaits



T

HIS EXOSKELETON ENABLES paralysed people to walk – for a relatively low price. Designed by California-based SuitX, the Phoenix costs $40,000 (£28,300), half the price of similar step-aiding frames. At 12.2kg, it's also half as heavy as its competitors. SuitX founder and Berkeley engineering professor Homayoon Kazerooni, 59, says the secret of the Phoenix's slimmed-down structure – and cost – lies in its ability to mimic humans.

Most exoskeletons have motors powering each joint, but the Phoenix features only two motors at the hips. Actuators at the knees have been ditched and replaced with hinges that stiffen when its wearer stands and loosen when their legs are swinging. "The human knee doesn't need to use power during walking. The Phoenix walks organically," says Kazerooni.

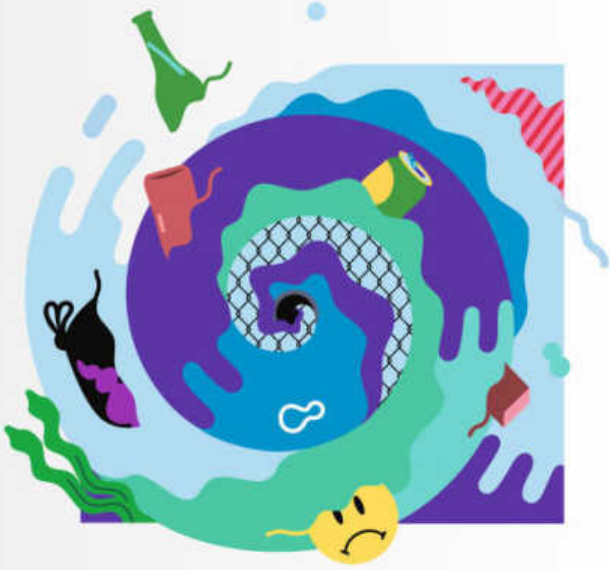
An Android phone can manage the frame's movements. "This way, doctors can adjust the exoskeleton's speed and gait. They can also see the history of how the users walk," he explains.

The Phoenix is not intended as a wheelchair replacement: it has a limited speed (approximately 1.8kph) and range (around four hours per charge), and is currently unable to assist in power-intensive tasks such as climbing a staircase. What it does offer is accessible freedom. Kazerooni, currently working on Phoenix 2, says that his main focus will continue to be reducing weight and price. "Speed is not an issue for me at this time; functionality is. I want to create affordable exoskeletons that walk smoothly." **Gian Volcipelli** *suitx.com*

PHOTOGRAPHY: ELENA ZHUKOVA. ILLUSTRATION: MICHAEL ARNOLD

A CLEANER MARINA

Seabin is an automatic rubbish bin that fights pollution



EVEN OCEANS need trash cans. The Seabin is a dock-based automated rubbish bin that catches floating plastic, oil and fuels. Australian surfers Andrew Turton, 40, and Peter Ceglinski, 37, developed the bin after witnessing growing pollution in marinas. "I used to be a product designer," says Ceglinski. "When I realised we didn't need the plastic products I was making, I quit my job." Ceglinski found an old factory in Palma de Mallorca, Spain, and transformed it into a Seabin workshop, where he also lives.

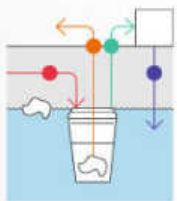
Ceglinski's invention offers a 24/7 alternative to the expensive "trash boats" traditionally used by harbours and marinas, which clean by scooping up rubbish in nets. The Seabin is most efficient in the marina's problem spots, where predominant currents amass heavy pollution. It's estimated to catch up to 1.5kg of rubbish per day – removing around half a tonne per year from the 250,000 tonnes the oceans are believed to hold.

The Seabin is fixed to a floating dock, above the water surface. A water pump creates a flow that sucks rubbish inside a recycled polyethylene bin and into a natural-fibre bag. The water is then pumped back into the marina. And don't worry about fish getting trapped: in four years of testing, the Seabins haven't caught a single one, says Ceglinski. "Fish simply stay away from the surface and the current that the Seabin produces," he says. If any fish did get caught, they would be freed by marina staff while emptying the underwater bin.

An Indiegogo campaign collected over $267,000 (£189,000) in January, prompting Malta to express interest in installing Seabins around its island. "An eco-label programme advised 250 marinas on its mailing list to get a Seabin to increase their rating," says Ceglinski. Eight Indiegogo backers paid the $3,825 campaign price for their exclusive prototype, but the eventual market price shouldn't exceed €3,000 (£2,300). French marina manufacturer Poralu Marine is making and distributing the first Seabins, which are scheduled to be ready to ship in late 2016. **PB** *seabinproject.com*

HOW IT WORKS

A pump draws dirty water and rubbish into the Seabin
Workers remove the collected litter
The pump carries the seawater on to land where it is filtered
The clean water goes back into the sea



HOW IS TECH CHANGING THE WAY WE MAKE MUSIC?

THE BIG QUESTION



STARSMITH

SONGWRITER,
DJ AND PRODUCER

"One innovation is with cloud tools such as Splice and Gobbler, which help collaboration between producers and songwriters. One user can upload an entire session to the cloud and another can log in and make adjustments to the project, much the same as with Google Drive. The streamlining of basic tasks in the studio definitely helps to fuel creativity. On the live music front, hardware such as the Novation Launchpad and Ableton Push have created a great hybrid that gives you the editing capabilities of a studio but are stable enough to be integrated into live performance." **PB**



ERIC WAHLFORSS
CO-FOUNDER AND CTO, SOUNDCLOUD

"Mobile is going to be the key growth area in music over the next ten years, for production as well as consumption. Technology has entirely changed the way music can be made, thanks to the sheer scale of opportunity now open to anyone. The ease of use of many modern tools has lowered the barrier for entry, which may have been prohibitive to aspiring musicians not so long ago. The social web has also changed the way music is promoted and consumed. Creators can discover fans, interact with like-minded people and collaborate on new projects."



ERIN BARRA
ARTIST AND CREATOR, BEATS BY GIRLZ

"Tech has changed writing, capturing, refining, marketing, distribution, sharing and discovering – no facet has gone uninfluenced. The tech I find interesting is the type that lets my creativity lead while allowing me lots of functionality. With non-linear digital audio workstations like Ableton and associated hardware like Push, I find the workflow to be liberating and tactile. Tech has significantly lowered the barrier to music-making already and I believe that will continue – we'll see much more activity in schooling for all ages and even more saturation in the field."



LUKE WOOD
PRESIDENT AND COO, BEATS ELECTRONICS

"When I started making music, I would ping-pong stems of tracks from one cassette to another and then play along, building up a song. It generally sounded horrible and required a lot of time. Now I can pick up a guitar and record a demo using *Music Memos* on my iPhone, export to GarageBand, plug in an iOS Fender Stratocaster for overdubs, use CME X-Key controller to arrange strings and Addictive Drums to create a drum part then plug in a USB mic for vocals. This ecosystem enables musicians to focus on writing, which is where all great music starts."



ANNIE GOSFIELD
COMPOSER

"Accessibility will continue to improve as memory becomes more affordable. Today's samplers are getting more powerful and precise – a composer's only choice used to be analogue tape and modular synthesis. Sampling tech, in tandem with a keyboard that can be programmed to control the sample, brings a pianistic approach to electronic music. Tech gives a more intuitive approach to performance: I can notate music as a five-line staff, helping to make my odd electronic sounds performable to anyone who can read music."

ILLUSTRATION: AISTĖ STANCIKAITĖ. PHOTOGRAPHY: MORITZ DOERSTELMAN



SPINNING A WEB ON THE FLY

Achim Menges' robots construct composite-fibre structures around crowd movements

The Elytra Filament Pavilion is part of the V&A's Engineering Season. It will also feature an exhibition on the work of pioneering engineer Ove Arup



They may look like spiders' webs, but the inspiration for architect Achim Menges' composite-fibre constructions is more insect than arachnid. "We copied the intricate micro-structure of the elytron, an extremely lightweight shell that protects the wings of flying beetles," explains the 40-year-old founding director of the University of Stuttgart's Institute for Computational Design. "These are made from continuous composite fibres, twisted into a double-layered structure."

This bio-composite fibre, called chitin, is also found in lobsters' exoskeletons, another inspiration for Menges' work. "Their claws are very stiff while their tails are very flexible, but it's all made of the same material," he explains.

As well as being lightweight and workable, this construction technique has another advantage: "We use a robotic process, with an incremental build-up of free-standing fibres, so we don't need a mould."

From May 18 to November 6, Menges's robot arms will weave a 200m^2 pavilion in the courtyard of London's Victoria and Albert museum. "Four sensors will monitor the behaviour of the people inside the courtyard and the structure will adapt to that," explains Menges.

Menges's methods reflect his belief that looking to the natural world for inspiration has more fundamental benefits than mere process improvement. "Nature behaves in a very counter-intuitive way to how we would solve problems as architects," he explains. "It forces us to question really deeply held principles of construction." **Kathryn Nave**

achimmenges.net

The WIRED Audi Innovation Awards are designed to highlight and celebrate people achieving extraordinary things. Judged by a panel of WIRED and Audi representatives, the awards will be presented at a ceremony in November

#WiredAudiAwards

WIRED Audi

INNOVATION AWARDS

/2016

Celebrating:

Innovation in AI

Most exciting moonshot

Innovation in experience design

Social innovation

Innovation in product design

Scientific breakthrough

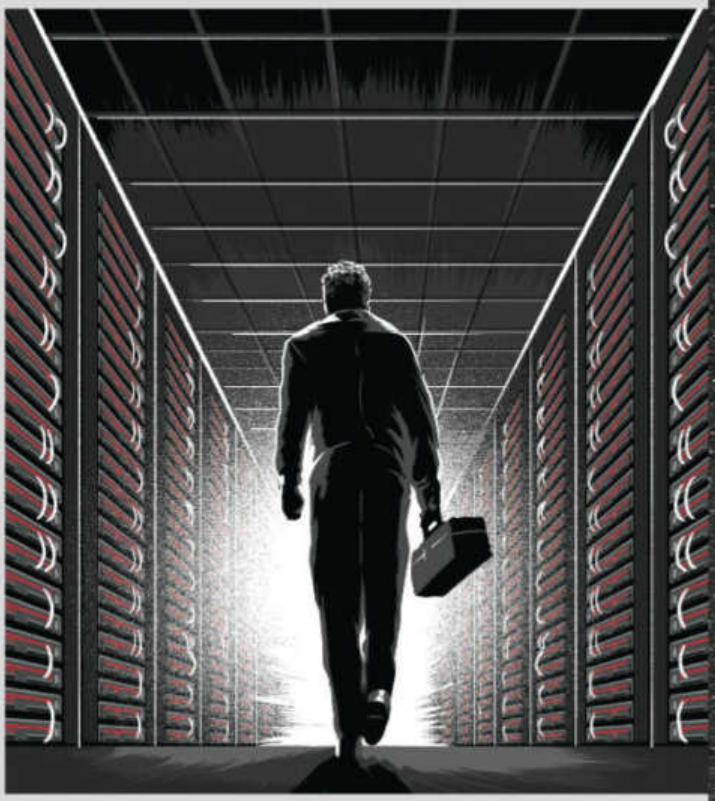
Leadership in innovation



1

GREATEST ACHIEVEMENT IN AI

Artificial intelligence is coming, whether we're ready for it or not. Computers can beat humans at games of knowledge, such as the TV show *Jeopardy*, and games of skill, like chess and Go. But which British individuals, teams and companies made the biggest impact on the field in 2016? Nominees in this category may be found in the commercial space or research institutions.



3

INNOVATION IN EXPERIENCE DESIGN

Which British company helped us see the world differently in 2016? This award celebrates the innovators in experience, from virtual and augmented reality to commerce, culture and creation.



4

SOCIAL INNOVATION

Tech can – and must – do good. Charities, NGOs and big industry are all embracing digital and design technologies to improve the lives of millions of people around the globe. Which UK organisation or individual changed the world for the better in 2016? Nominees may be building physical products, working on policy or implementing large-scale reforms of services or tools.

5

INNOVATION IN PRODUCT DESIGN

WIRED loves great gear. But which UK designer, manufacturer or creative made the most brilliant and beautiful product in 2016? We're looking for objects with incredible aesthetics – whether they be apps, analogue goods or appliances – that exceed our expectations of ergonomics. Which are the designs that redefine categories and re-shape how we think about goods?

6

SCIENTIFIC BREAKTHROUGH

Which scientific breakthrough thrilled and amazed us in 2016? This award recognises the biggest breakthrough from the UK's science sector – whether that's in astrophysics, biotech or genomics. Nominees will have worked on discoveries that unlock long-standing problems and scientific endeavours with the potential to have a long-term impact on human wellbeing.

2

MOONSHOT OF THE YEAR

Innovation requires daring. Who in the UK dreamed biggest and boldest in 2016? We want the teams and individuals striving to go beyond business as usual and break down barriers in whatever sector they're working in. This category will be decided by the public. Details of how to vote will be announced soon.

WIRED Audi

INNOVATION AWARDS

THE AWARDS

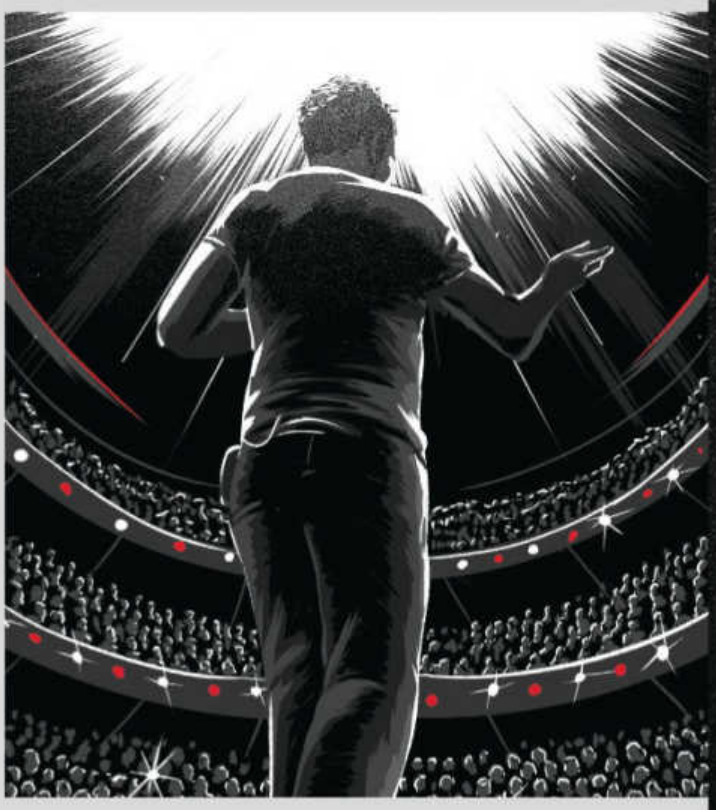
WIRED and Audi UK share a mission: to bring about progress through the creative use of technology. This awards series is a way to recognise the innovative, ground-breaking work being done around the world in a number of industries. The winners will be chosen by experts in each category, with input from senior Audi UK and WIRED representatives. The moonshot of the year category will be decided by public vote.



7

LEADERSHIP IN INNOVATION

Innovation requires leadership. This award was created to recognise the British leader who has inspired their personnel – or the public at large – to greater heights over the course of their career. The innovative leaders nominated in this category may be working in private enterprises, public institutions, establishments of higher education and beyond.



A

NEXT ISSUE

Be sure to check in with the WIRED Audi Innovation Awards next month in WIRED magazine or on wired.co.uk, as we begin to announce the nominated people and companies in each catogory shortlist. ***#WiredAudiAwards***

Audi
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IDEAS BANK

JONATHON KEATS

LET'S MAKE MOOCS LESS MEEK

In spring 1961, the American inventor Buckminster Fuller told a group of Southern Illinois University administrators that a new campus they were planning would soon be obsolete. He informed them that classroom learning was finished. Instead, students would gain knowledge through "an intercontinentally networked documentaries call-up system, operative over any home two-way TV set". All the world's great ideas would become freely accessible to anyone anywhere, instantaneously elucidated by the world's foremost educators. And he predicted that forward-thinking universities stood to benefit because educational automation was "the upcoming major world industry".

Fast forward half a century and, although his talk of two-way TV has been almost forgotten, his educational vision has an uncanny resemblance to massive open online courses (MOOCs). More than 500 schools worldwide – from Harvard and MIT to Southern Illinois University – have provided content to the non-profit edX consortium or the edutech company Coursera. A third MOOC provider, Udacity, has recently become a "unicorn", attaining a $1 billion (£700m) valuation from investors.

All of this has happened in just a few years. In autumn 2011, Stanford professor Sebastian Thrun offered free online enrolment in his artificial-intelligence class, attracting 160,000 students from 190 countries. The following spring, MIT professor Anant Agarwal made a similar offer for his introductory electrical-engineering course, drawing an online class of 155,000. On the strength of these numbers, Agarwal launched edX and Thrun founded Udacity, while two of Thrun's Stanford colleagues started Coursera. Despite differences in their business model, all three shared an almost messianic idealism – the conviction that university-level education could become universal – and enlisted the best educators. In a 2013 TED Talk about edX, Agarwal captured the ethos in a single slogan: "Everything has to change."



Jonathon Keats is the author of *You Belong to the Universe: Buckminster Fuller and the Future* (Oxford University Press)

By some measures, everything *has* changed as a result of MOOCs. Growth has been phenomenal. According to online course operator Class Central, the number of people who signed up for at least one MOOC surpassed 35 million in 2015, more than double the number just one year earlier, and the number of courses surged to approximately 4,200, nearly twice the number in 2014. But these figures conceal an opposing trend. Faced with class completion rates of as little as five per cent and financial pressure from funders, MOOC providers have narrowed their ideals. The emphasis is increasingly on practical coursework and on charging pupils for certificates of completion. Coursera CEO Richard C Levin, formerly the president of Yale, recently told *The Chronicle of Higher Education* that his company's "product-market fit" lies in professional development. Thrun, who now offers a money-back guarantee that Udacity students will find employment, recently told WIRED, "The ultimate objective of education is to find people a job."

There's nothing dishonourable about making job training more accessible, but the rapid retreat of MOOCs into vocational banality represents a squandered opportunity. The potential can be appreciated by looking back to the vision Fuller had for Southern Illinois University. For him, the potential of automation was to nurture universal curiosity, preparing the next generation to care for the planet they were inheriting. The goal was generalism, to interest people in everything, so that they could grapple with complexly interconnected global problems.

As the world's problems become more complicated, and the future more precarious, Fuller's impetus is increasingly apposite. And the technology underlying MOOCs – as well as their reach – provides a solid platform for broadening people's interests. MOOCs need to be linked across disciplines, with recommendation engines like those employed by Netflix and YouTube to entice students to compulsively take up new interests. Course completion rates need to be de-emphasised in favour of curiosity quotients.

Vocational training is just one thin layer of education. For edutech to be worthy of its name – and for everything to truly change – MOOC platforms need to make every mind as expansive as the world wide web.

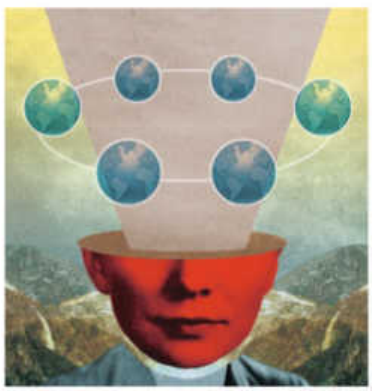


ILLUSTRATION: HAYLEY WARNHAM

IRIS BOHNET

TURN A BLIND EYE TO FIRST IMPRESSIONS

Blind evaluations are en vogue. Compose Inc, a cloud-storage firm in California, no longer asks job applicants for their CVs but instead has them complete tasks relevant to the job. Across the board, such tests have been found to be significantly better at predicting future performance than traditional job interviews.

In fact, unstructured interviews are particularly bad at predicting a person's future performance. They are fraught with bias. Research by sociologist Lauren Rivera suggests that interviewers tend to want to replicate themselves, or as one recruiter said: "You use yourself to measure because that's all you have to go on." Analysing hiring in investment banks, law firms and management consulting firms, Rivera found that the degree to which a candidate's backgrounds, hobbies and self-presentation was similar to a company's existing employee base was decisive in candidate evaluations.

Dozens of studies show that unstructured interviews primarily add noise because human minds are incapable of separating relevant data from irrelevant data. A few years ago, an opportunity to better understand this presented itself in Texas when the state realised that it did not have enough physicians. It asked the University of Texas Medical School in Houston to dramatically increase the number of admitted students late in the academic year. At that time, only students who had not been admitted anywhere were left. But what seemed like a catastrophe to the university turned out not to matter at all. The bottom-ranked students performed just as well as the top-ranked ones – leading the researchers to question whether interviews should be replaced by a lottery among applicants.

Looks also matter. We tend to prefer the good-looking, and what is more, expect them to be better performers and more worthy of our trust. But attractive people are as trustworthy as the average person, research shows. However, when the good-looking do not live up to those expectations, they are punished for it. Generally, we do not like people who violate our beliefs – whether related to how we expect attractive people to behave or an engineer or a nurse to look.



Iris Bohnet is the author of *What Works: Gender Equality by Design* (Harvard University Press)

This is why blind evaluations have played an important role in auditions. The Boston Symphony Orchestra, and later most of the major orchestras in the US, asked musicians to audition behind a curtain. Although in theory orchestra directors should not care about who plays the bassoon but just about the music that is produced, it turns out they do, often without their conscious knowledge. In the 70s, only five per cent of musicians in the top five orchestras in the US were female. Today, women make up almost 40 per cent. Research by economists Claudia Goldin and Cecilia Rouse shows that the introduction of screens increased the likelihood that women would advance to future rounds by around 50 per cent and therefore increased the fraction of female hires.

Adopting what worked for orchestras is not always possible. But at a minimum, a practice still prevalent in many European countries and Israel that encourages applicants to include head shots with their CVs should be stopped. Research from Israel demonstrated that employers were more likely to call back attractive men than average-looking male applicants. Attractive female applicants did not reap a beauty premium. Indeed, in western countries, looks appear to matter in particular for men – even though evidence does not suggest that beauty is a credible marker for underlying characteristics such as intelligence.



But you can do more. To guard against irrelevant factors clouding your judgement, evaluate job candidates comparatively. In a recent study with Max Bazerman and Alexandra van Geen, we found that evaluators who use a comparative perspective are much more likely to focus on relevant predictors of future performance, instead of less helpful information, such as a person's gender. Indeed, our minds have an intrinsic need to rely on comparisons to understand what is going on. Whether or not you are drawn to a particular job candidate is related to the people you are used to seeing in this job. This is how stereotypes such as engineer equals man or nurse equals woman take hold in our minds. We then use them as measuring rods when evaluating others. To debunk these internal comparators, force yourself to compare a given candidate with real alternatives.

Comparative evaluation is the right and smart thing to do. Many companies have begun to take encouraging steps in that direction. Google, for example, compares a given evaluator's assessments with those of others and finds that such calibration diminishes bias. But this is not limited to large tech giants. You can do it too. Tools are available to assist employers in evaluating talent more objectively. Check out Applied, GapJumpers or Unitive recruitment platforms that anonymise applicants, introduce work sample tests and help you with comparisons and aggregation across evaluators. Instead of picking those who look the part, you can find the best talent and level the playing field.

ILLUSTRATION: MATTEO BERTON; BENEDETTO CRISTOFANI



PATRICK DIXON

THE TIMES THEY AREN'T A-CHANGIN'

It is far easier to predict the future than you may think, because many things change more slowly than media hype suggests. I know this from advising corporations on the impact of key megatrends over the past 20 years.

I'm not talking about share prices, commodity prices or currency rates. Anything to do with markets is as difficult to predict two months ahead as the British weather. And sudden events can spread with global force in a hyper-connected world, so leaders need to be agile, with backup plans.

Every now and again in history there is a genuine step-change – the collapse of communism for example, or a global war, or the creation of the web – but such things are rare. That's why most boardroom debates about the future are not usually about the direction of a trend, which tends to be fairly obvious, but about timing or speed of that trend.

Take the past two decades. How much has really changed in day-to-day life, in ways we did not expect? Here is an important test: imagine that a senior executive friend of yours had a terrible accident way back in 1998 and since that day has been in a deep coma. One day he wakes up in hospital and almost immediately asks to see you.

How long would it take you to update him on all the most important things that have happened since 1998? My guess is less than a couple of hours.

He will hardly be shocked when you tell him about smartphones, the internet of things, big data or cloud computing. He knew back in 1983 that telco and IT prices would continue to collapse, with devices shrinking rapidly, and by the mid 90s it was obvious that everything would one day be connected everywhere.

In 1997, he was using a Nokia 9800 phone with email, spreadsheet, word processor, SMS, browser, apps and camera. His teenage daughter was having 16 social-media chats at once. The web was hitting retail sales, the travel industry and banking, and data was being used widely in marketing.

He knew then that China would be the world's largest economy in the next 25 years, and that Asian nations would experience an astonishing rise in middle-class wealth. He expected the world's population to peak at well over nine billion by 2050, mass migration to cities or across continents, rapid improvements in life expectancy, greener energy and growing worries about sustainability.

Nor would he be surprised to learn about a prolonged global recession, or about more banking scandals, or about a second Iraq war, with revolutionary chaos in the Middle East, and many terror attacks in western cities by Islamist extremists. Such things were recognised as future possibilities, debated by government leaders, and anticipated in books such as my own.

Walk him down the streets of London, Paris or New York. Take him to a typical office of a large company or family business. You will struggle to show him anything extraordinary – apart from people using mobile devices more often. Today, we are dressed in similar ways, do similar things at work and to relax, take children to similar schools where they learn in similar ways (apart from using the web more).

Perhaps the only thing that will really shock him is how little has changed. Many bank branches still exist, and more cash is used across America and the EU than ever, despite predictions of a cashless society. Paper books still sell globally, along with physical newspapers, particularly in nations like India; sales of children's books soared by over ten per cent in the UK last year, while Kindle sales flattened. Most people still commute to work, and complain about volumes of email. Pure home-working is rare. Business travel has continued to grow, despite rapid adoption of video conferencing.

Cars, fashion, music styles, radio, TV soaps, global sporting events, film plots and live theatre are all much the same. Yes, there has been a shift from watching live TV to TV-on-demand and social networking or web surfing, but such things would not be such a great surprise to him.

Most things at home are similar or identical – lights, heating, taps, alarms, microwaves, cookers, fridges or washing machines. And they are likely to continue to look similar or identical, even when all electrical devices are networked in smart homes.

And despite all the headlines about robots taking over the world, the truth is that sales of robots in factories have grown a mere seven per cent a year over the past decade and a half – very slow compared to the explosive sales of smartphones and related technologies.

What this all points to is one of the greatest delusions in human history, one which can stop rapid decision-making, kill investment and stifle innovation. It can easily become an excuse for lazy thinking about strategy.

So then, we should focus with confidence on major factors which affect our long-term future, in particular on megatrends which are most likely to affect our own organisation, while also addressing how customer needs are evolving in an agile and creative way.

Yes, there will always be industry disruptions and economic crises, and we should take them seriously, with well-planned contingencies to stay one step ahead, but history shows that they are often over-played.



Patrick Dixon is chairman of Global Change and author of *The Future of Almost Everything* (Profile Books)

JONATHAN ADIRI

KIM KARDASHIAN COULD SAVE YOUR LIFE

ber, Facebook, Alibaba and Airbnb all have something in common: none of these companies owns the asset that generates its unprecedented revenue (taxis, content, inventory and property rental). This new business model is overhauling key industries throughout the economy. What is the equivalent in healthcare?

Healthcare is an ecosystem mired with inefficiencies. The US healthcare industry costs a whopping $2.9 trillion (£2tr) annually, eating away at 18 per cent of GDP. That's far beyond peer nations in per capita healthcare costs. And if that seems like a colossal expense, take note – healthcare is predicted to soar to 21 per cent of US GDP by 2021. That's more than all of China's annual private consumption – food, cars, education – and it's more than annual oil consumption worldwide. Add to that the ageing populations throughout the world and it's clear – something's gotta give.

But who's going to cure the west's ailing healthcare system? There are a number of moonshots – large-scale government or enterprise-backed initiatives – promising to revolutionise the sector, such as gene therapies, with powerful gene-editing technologies like CRISPR promising to transform medicine. Costs associated with gene therapy have plummeted – where it once cost $100 million to decode one gene sequence, it now costs $1,000.

But it's not only grand initiatives that are transforming healthcare. There is a swarm of digital healthcare startups that is seeking to unbundle specific health challenges.

Moonshots rely on hundreds of billions of dollars of government grants or research endowments, but startups are able to disrupt their niches on very little money. And that's because someone else is paying to develop much of their technology – you, your friends and Kim Kardashian.

Our exploding online social interaction – a world where we reach for our smartphones a typical 155 times a day, where 52 billion messages are sent daily via *WhatsApp*, where you, Kim Kardashian and everyone else upload two billion pictures daily – puts enormous pressure on the smartphone industry to create and upgrade the technologies that accommodate this behaviour.

This includes super-high-resolution cameras, vast cellular bandwidth required to upload all our photos to the cloud, and the seemingly endless storage technology.

This very technology that allows us to keep up with the Kardashians also makes our smartphones unparalleled medical devices. So, for example, a startup called Tissue Analytics lets you take pictures of a wound over time on your smartphone, allowing doctors to determine whether it's healing or festering. AliveCor lets you capture an electrocardiogram at home and alerts doctors if something is wrong with your heart via cellular technology. Netra Labs lets you take eye tests at home using mobile technology.

China's internet giant Tencent recently acquired a major stake in Guahao, a local startup that grew a massive user base as it enabled real-time geolocated physician appointments. This service was integrated into the *WeChat* app, as part of Tencent's broader vision of social digital healthcare. And there's a hardware and medical device arm – evident in the company's recent unveiling of its own glucometer.





Jonathan Adiri is the founder and CEO of Healthy.io and former chief technology officer to Simon Peres, then president of Israel

From a macro perspective, the Chinese healthcare opportunity in the coming decade will be equivalent to the scale of the manufacturing growth in the past two decades. Today, after the 2010-2015 plan added 60 per cent of the population into the mandatory healthcare coverage (now more than 90 per cent), the country is still spending only half of the OECD average on healthcare. Assuming the government realises its healthcare vision for the coming decade and reaches OECD-level spending as share of GDP (11 per cent), Chinese healthcare will grow into an annual $1.4 trillion market. The local ecosystem is aligning to capture this opportunity.

Because of all we are demanding from our mobile phones and social networks, entrepreneurs with limited resources can now do what only governments could do ten years ago. All of these companies and hundreds more are leveraging today's Kardashianomics to make healthcare easier, more collaborative and effective while significantly reducing costs and freeing up our lives.

Thanks to these digital wonders that define our engagement with today's technology and the startups that are harnessing it, our healthcare system is going to improve exponentially, and we as individuals are going to live longer... and better. And we've got you and Kim to thank for it.

ILLUSTRATION: DANIEL DOWNEY

PREPARE TO BE SEDUCED



Inspired by the iconic 33 Stradale, the Alfa Romeo 4C Spider will this year pay tribute to 50 years of the original Spider with a new UK Limited Edition model. The Alfa Romeo 4C Spider '50° Anniversario' is limited to just 50 cars and includes its own unique number between 1& 50, ensuring true exclusivity.

This Alfa Romeo 4C Limited Edition is made with the same materials you would expect to find in a Formula 1 car. From the high performance carbon fibre monocoque which sits at the heart of the car, to the sports suspension and racing tyres, this car demonstrates a true sporting heritage. The specification also includes double racing exhaust tailpipes, leather seats with contrast stitching, matching leather dashboard and luggage plus much, much more. Available in the iconic Competizione Red, Madreperla White, both with a Tri-Coat finish or the signature Giallo Prototipo yellow.

The Limited Edition has arrived. Reserve your choice today.

La meccanica delle emozioni

Models shown are Alfa Romeo 4C 1750cc TB 240 hp ALFA TCT 50th Anniversary Limited Edition at £67,500 OTR. Official fuel consumption figures for the Alfa Romeo 4C Spider: Urban 28.0 (10.1 l/100km); Extra Urban 55.4 (5.1 l/100km);Combined 40.9 (6.9 l/100km). CO_2 emissions 161 g/km. Fuel consumption and CO_2 figures are obtained for comparative purposes in accordance with EC directives / regulations and may not be representative of real-life driving conditions.

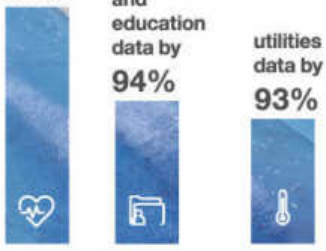

Welcome to the cognitive era.
A new era of technology.
A new era of business.
A new era of thinking.

A cognitive business is a business that thinks.

A new era of technology is giving rise to a new era of business, made possible by three historic shifts:

1. A world awash in data.

80% of all data is invisible to today's computers.
Now consider that by 2017 healthcare data is expected to grow by



2. A world reinvented in code.

Take just one example: a car is now a platform for software, containing

100 million lines of code—93 million more

than advanced passenger jets.

3. The advent of cognitive computing.

Technology that takes in data in all forms – including unstructured – and understands it, learns from it and reasons through it. This is what business has been waiting for.
IBM Watson™ now works with over **70,000 developers** and **350+ partner companies** who have launched **100 cognitive applications**

Digital is not the destination but the foundation for a new era of business; we call it cognitive business, and IBM Watson is the platform. Today Watson is helping doctors reimagine medicine, and leaders reshape industries as diverse as retail, banking and travel. And Watson is taught by industry experts, so their know-how can reach more practitioners.

Cognitive business is here.

Cognitive engagement.

In government: Watson is helping cities run better. Working with a startup, Watson's question answering and natural language capabilities let users ask common questions – "How do I find a lost pet?" and "How do I pay a parking ticket?" – without waiting on the phone or for an email reply.

Cognitive deepens engagement.

Cognitive products and services.

In media: A leading broadcast network grew viewership through look-alike modelling, ratings and streaming data analysis. They saw faster, more accurate ratings predictions, in some cases six weeks in advance of a show's release.

Cognitive products never stop adapting.

Cognitive processes and operations.

In travel: A new travel startup is teaching Watson how to help travellers find personalised recommendations through thousands of sources, user data points and local area knowledge.
The company is already transforming the travel process, from inspiration to destination.

Cognitive brings more certainty to business.

Cognitive expertise.

In law: Watson is being trained in legal language and natural language, so it can help answer legal questions framed in ordinary speech. Now being piloted in 20 of the world's top law firms, Watson can help cut research time from hours to seconds.

Cognitive elevates expertise.

Cognitive exploration and discovery.

In science: Working with a leading medical school, Watson helped scientists identify six proteins that modify p53, a protein related to many cancers. It typically takes the life science industry years to accomplish what Watson did in mere weeks.

Cognitive is accelerating high-stakes research.


outthink
trends
Cognitive inventory is here.
Now retailers can combine predictive analytics with demographic data to make sure hot items stay stocked in the right styles, colours, and sizes.


outthink
risk
Cognitive finance is here.
Now clients can analyse richer and more diverse data sets to know which merger and acquisition deals are more likely to pay off.


outthink
threats
Cognitive security is here.
Now banks can accurately detect new fraud patterns and combat fraudulent events as they happen.


outthink
cancer
Cognitive oncology is here.
Now doctors can use Watson to analyse patient data against clinical expertise and external research to help identify the best course of treatment.

Is your business ready to be a cognitive business?

You can start today. Watson is open for business in the cloud, with 28 API services that let you integrate cognition into your company's digital presence. But to create a true cognitive business, you'll want to drive this deeper into your enterprise. Here's how:



Design a cognitive strategy.
Which experts will train the system? Which products, services, processes and operations should be cognitive, and which not? What data do you need?

IBM cognitive business solutions is supported by over 2,000 specialists, the collective experience gained in over 50,000 analytics engagements and world-leading IT consulting services and partnerships, such as Facebook.

Extend cognitive with analytics.
Ensure you can collect and curate the right data – structured and unstructured. The data you own, data from others and data available to all.

IBM Analytics leads the way with data partnerships, such as Twitter and The Weather Company, and enables anyone engaging with data to ask questions, uncover patterns and pursue breakthrough ideas.





Move to a cognitive cloud.
Optimise cloud services for your industry, your data sets and cognitive APIs. The hybrid platform you build on must be able to integrate front-office data with core systems of record.

IBM Cloud offers a robust, complete and secure hybrid cloud. And IBM Bluemix™ is growing 10 times faster than the overall PaaS market, with more than 100 services in 99 countries[1].

Build a cognitive infrastructure.
Evolve your IT infrastructure for cognitive workloads.

IBM Systems – from software that integrates and manages APIs, to POWER8® and mainframe servers, to flash and software-defined storage – are designed for the data and analytics required to deliver cognitive services. And IBM Global Technology Services® is starting to apply Watson to the way services are delivered.





Adopt cognitive security.
As cognition moves into every part of your business – and every part of the world – it is essential that every transaction, piece of data and interaction becomes secure. Your business, and your reputation, depend on it.

With a team of 6,200 security professionals in 36 security centres worldwide, monitoring 133 countries and 20 billion events per day, IBM Security can act on threats before they become attacks.

Building on these fundamentals and tapping the power of Watson, your whole business can become cognitive. It will work more smoothly, move faster and help you make better decisions.

When your business thinks, you can outthink.

ibm.com/outthink/uk

[1]ESG: Platform-as-a-Service Usage and Satisfaction Study, April 2015, http://www.esg-global.com/research-reports/platform-as-a-service-usage-and-satisfaction-study. All statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.

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FETISH



The AK T1's inputs include microSD, USB, optical and auxiliary, plus streaming over Ethernet, Wi-Fi and Bluetooth



WORDS: KATHRYN NAVE. PHOTOGRAPHY: MITCH PAYNE

GEAR

<

ASTELL & KERN AK T1

Astell & Kern is best known for its range of high-resolution portable media players. Its first all-in-one home media system now lets you share the sound by integrating its 24-bit/8-192kHz audiophile-quality sample rate into a 100cm-tall speaker tower. The six speakers are driven by a hybrid amplifier system. An analogue amp delivers crisp highs to the tweeters; a rich midrange and deep bass for the subwoofers comes courtesy of a digital system. *£2,499 astellnkern.com*

The elongated pentagonal body lets you position it for optimum sound – be it low on a table or high up a wall



WIRED LOVES

The 6.2kg bar is 100 x 13.1 x 12.5cm, and was created by Torsten Valeur, who has been designing B&O products since 1997

^

BANG & OLUFSEN BEOSOUND 35

A pair of centrally placed four-inch bass drivers coupled with a three-quarter-inch tweeter on either end give this characteristically stylish Bang & Olufsen all-in-one system a balanced but room-filling sound. Integrated streaming services including Spotify, Deezer and TuneIn can be controlled from the device's touchscreen, the remote or the *BeoMusic* app. The B&O PLAY system allows connection to other B&O products for multi-room music. *£1,795 bang-olufsen.com*



The ring flash's LEDs also indicate remaining shots and available battery power

The I-1's app enables remote trigger and timer shots, and offers tips and tricks such as double exposures. Developed photos can be scanned for your photo stream

WIRED **LOVES**



Synced with a smartphone app via Bluetooth, the I-1 can be controlled remotely

THE IMPOSSIBLE PROJECT I-1

After spending eight years reviving Polaroid's old film formulas and restoring their classic instant cameras, The Impossible Project has broken out with its own model – the first new camera in more than 20 years to be created for the original instant film format. Designed by Swedish electronics company Teenage Engineering, the I-1 gets serious about instant photography, including a ring flash – the first on a camera of this type – which combines eight focused long-range LEDs with four diffuse ones to prevent washed-out close-up portraits.

Advanced features such as manual control over shutter speed and aperture are offered through the first companion app for an instant camera, and the point-and-shoot design beloved of Polaroid aficionados is preserved in a simple rubber-feel body which incorporates a mechanical viewfinder alongside automatic focus and exposure setting. Whether amateur or advanced, experimentation is encouraged with app-delivered advice and tools for creative techniques, including light painting and double exposure. *£229 the-impossible-project*

METROPOLIS NOW

Bring the outside in with our pick of city-inspired design

All 32 pieces, including The Shard by Renzo Piano, are cast in injection-moulded acrylic

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5



6



Stalaclight-1 is 250mm in length and uses a 5.5 Watt LED bulb

FETISH

1. SKYLINE CHESS

If castles, kings and queens seem like the tokens of an anachronistic social hierarchy, then swap them for this century's symbol of wealth and power – the skyscraper. In this London-themed chess set, Big Ben takes rook, the pawns are terraced houses and you call checkmate by knocking down One Canada Square. *£80 skyline-chess.co.uk*

2. TALIA SARI YOU ARE HERE

Whether it's the perfectly perpendicular grid of New York's streets, Paris's radiating avenues or London's tangle of alleyways, the distinctive urban layouts of nine major cities – including Tokyo, Barcelona and Jerusalem - are easily recognisable in Tel Aviv-based jewellery designer Talia Sari Wiener's handmade collection of necklaces, rings and brooches. *From $64 taliasari.com*

3. STELIOS MOUSARRIS WAVE CITY COFFEE TABLE

Bringing the mind-bending dream physics of *Inception* into waking life, the Wave City table curves up to support a flipped-over cityscape. Each miniature building is 3D-printed, then attached to the steel-reinforced wooden frame. *€6,500 mousarris.com*

4. BOZU INDUSTRY COLLECTION VASES

Inspired by the work of influential German photographers Bernd and Hilla Becher, who obsessively chronicled the typology of industrial architecture, these vases are handcrafted in Jingdezhen, the ceramics centre of China, and sit on gold-plated stands. *€89 bozu.it*

5.NAIHAN LI I AM A MONUMENT CCTV WARDROBE

To translate the Chinese garden tradition of miniaturised shrine architecture into indoor furniture, designer Naihan Li took her inspiration from more modern monuments, including this rosewood wardrobe that doubles as a 1:100 scale replica of the iconic CCTV headquarters in Shanghai. *£poa naihanli.com*

6. DAVID GRAAS STALACLIGHTS

Flipping architectural convention upside down, David Graas's Art Deco-inspired skyscraper shades turn your ceiling into an inverted cityscape. The 3D-printed shades hang directly from low energy LED bulbs, which emit minimal heat, ensuring you don't end up with melted plastic stalagmites on the carpet. *€175 davidgraas.com*

WORDS: KATHRYN NAVE. PHOTOGRAPHY: MITCH PAYNE; ROGER STILLMAN

TEST

CLICK ON TO CLICK

WIRED appraises the DxO One, a high-end iPhone accessory, to see if it's capable of replacing your pocket compact camera

The DxO One attaches to an iPhone or iPad via the Lightning connector and, thanks to a new firmware update, is now also able to function independently, using the thumbnail-sized OLED touchscreen to compose your image.

Once attached to your device, it's simple to control via the *DxO One* app, which integrates nicely into iOS. Image quality is excellent with rich colours and detail, and shallow depth-of-field effects are easily acheived. Shooting in RAW format also means you can bring back any detail lost in low-light JPEG images which may have succumbed to smudging.

It feels slightly cumbersome when paired with an iPhone, and although you're able to save manual settings when it's detached from a device, you'll need to reattach it to adjust them.

Battery life is problematic, too. The DxO One isn't going to last you a full day and using the app for extended periods is bad news for your phone.

Despite having the manual control and image quality of a pocket camera, it also has the price tag of one. So the DxO One remains a superior, but expensive, accessory.

7/10 *£399 dxo.com*

Lens 11.9mm
Sensor 20.2MP CMOS BSI 1-inch (13.2 x 8.8mm)
Maximum aperture f/1.8
Weight 108g
Dimensions 67.5mm x 48.8mm x 26.2mm



The one-inch 20-megapixel sensor is comparable to that on the Sony RX100 III

HOW WE TESTED

WIRED and still-life photographer Mitch Payne used the DxO One to shoot in a variety of conditions, including low light, landscapes, selfies and street scenes. We tested it attached to an iPhone, as well as device-free to assess the framing assist function.

WIRED PHOTOGRAPHER MITCH PAYNE'S VERDICT



"The DxO One has an amazing depth of field and ISO range. Usability is simple and the quality is better than the iPhone alone. It's also fantastic if you're hot on social media and want to upload on the go, although a large JPEG is around 5MB, so it will eat up your phone's memory. It folds up nicely and has a pop-out lens cover, but it would be great if it came with a case too."

Digital extra!
Download the WIRED app to see images taken with the DxO One

WORDS: AMY DAVIES. PHOTOGRAPHY: MITCH PAYNE



HA-2

EUROPEAN HI-FI USB DAC/HEADPHONE AMPLIFIER OF THE YEAR 2015-2016

HA-2 is a compact headphone amplifier and USB DAC featuring ESS Sabre[32] Reference ES 9018-K2M DAC chip and support for 384 kHz/32-bit PCM and DSD up to 11.2MHz

EISA AWARD Best Product 2015-2016 USB DAC/HEADPHONE AMPLIFIER OPPO HA-2

"HA-2 is the smart choice for those seeking a polished-sounding and gutsy performer that's keenly priced."

WHAT HI-FI? AWARDS 2015 DACs Best DAC under £400 OPPO HA-2

"For £250, you'll struggle to find better detail or dynamics from a headphone amplifier and USB DAC."

Hi-Fi Choice RECOMMENDED

"A gem of a headphone amp/DAC at a very competitive price. Deserves to win plenty of friends."

hi-finews EDITOR'S CHOICE

"It's this combination of power and finesse that's so alluring in something so affordably priced."

avforums BEST BUY AWARD

"...a crushingly competent piece of equipment for the asking price."

oppo

oppodigital.co.uk/where-to-buy

HEAD TO HEAD

THE WIRED SCREEN-OFF

We pitted two laptop/tablet hybrids against each other. Did they flip our lid, or are they Jacks of all trades?

1. MICROSOFT SURFACE BOOK

8/10
FROM £1,299

At first glance, Microsoft's latest laptop looks like, well, just a laptop. But remove its display and it turns into an attractive, slimline tablet. Just press and hold the keyboard removal key to activate what Microsoft calls "muscle wire". An electric current is sent through wires that connect the display to the keyboard, causing them to release. It's efficient, and feels secure when its clicked back into place.

The so-called "dynamic fulcrum hinge" between keyboard and screen moves smoothly, satisfyingly and easily, and is stiff enough to hold the display at whatever angle you wish.

The 13.5-inch 3,000 by 2,000 display looks great. It's bright and sharp – but it's no match for the Pixel C's superior screen. The backlit keyboard is also impressive, if not a little springy. The large glass trackpad is very useful, and unlike, say, Apple's MacBook, this one actually travels when you click it.

The Surface Book comes supplied with the Surface Pen, a stylus which magnetically attaches itself firmly to the left side of the display. The nib on the pen is fine and to undo mistakes you turn the stylus upside down and use the virtual eraser at the top. That top is also a button: click it and the Surface launches OneNote even from sleep, with other functions customisable, too.

The keyboard contains most of the laptop's battery and its graphical processing unit, so when you detach the display to use it as a tablet, you're left with a less powerful machine that's unable to handle more power-intensive tasks in Photoshop or AutoCAD.

Because this is a full Windows 10 machine, it comes complete with a raft of Microsoft's latest extras, such as the face-recognition Hello screen. And it's powerful, thanks to an Intel Core i7 processor, 16GB of RAM and 512GB SSD of storage. This is a highly capable machine that is competent, fast and smooth.

What it's not, however, is cheap. Price apart, though, this is a powerful, versatile and much more stylish machine than many would reasonably expect from Microsoft. *microsoft.com*

2. GOOGLE PIXEL C

7/10
FROM £598

The well-built Pixel C's glossy finish makes for an attractive package. And it's light (916g), thanks in part to a display that measures just 10.2 inches.

The two halves cling to each other magnetically to create an effective and slim unit. To configure it for use, the screen is laid face-up on the top edge of the keyboard until held by a magnet and then tipped upwards, supported by a hinge. This feels unusual at first but it works well, matching a secure feel with ease of disassembly.

The keyboard feels a little cramped and the lack of backlighting is a shame. There's less travel in the keys than, say, the Apple iPad Pro with its curious but effective cloth-covered keyboard. It's also more responsive than a traditional Bluetooth keyboard, which tends to go to sleep exactly when you want it to be ready to type. There's no trackpad, though, which puts it at a disadvantage against the Surface Book.

Its sharp, bright display and crisp colours look great, and there is enough detail to make the tiniest small print legible. Video playback is also smooth, thanks to the nippy Nvidia Tegra X1 64-bit processor, Maxwell GPU and 3GB of RAM.

The Android software brings both benefits and drawbacks: use the Pixel C as a tablet and you have all the Android games and apps you'd need, but laptop productivity isn't Android's strongest suit. There is a *Word* app, of course, and Google's web-focused apps suite is strong, but specialist programs aren't as common as on Windows 10. As such, the Pixel C is a less versatile laptop replacement than the Surface Book. Used as a media-consumption machine, though, it works brilliantly with the keyboard removed.

This is more affordable than the Surface, but at £598 for the 64GB model plus keyboard, cheaper tablets are available. *pixel.google.com*

HOW WE TESTED
Both laptops were checked for battery life by running movies and audio. They were then used for tasks ranging from word processing to manipulating images in Adobe Photoshop. For the Surface Book, the stylus was used in painting programs and *OneNote*. Both machines' built-in cameras were also assessed.

WORDS: DAVID PHELAN. PHOTOGRAPHY: MITCH PAYNE

TEST

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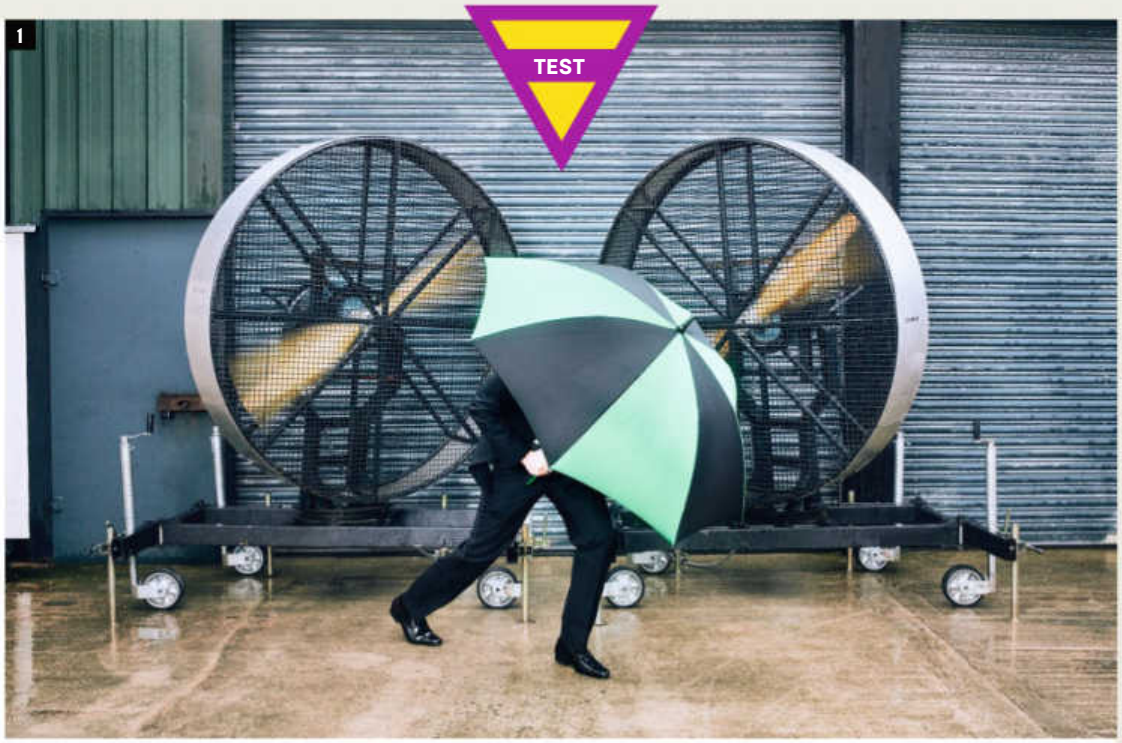


Microsoft's Surface Book weighs in at 1.58kg and its 13.5-inch screen displays at 267 pixels per inch.



The Google Pixel C is a featherweight 916kg but its 10.2-inch screen packs in an impressive 308 pixels per inch.

TEST



1. FULTON CYCLONE
This supersize golfing umbrella offers the greatest protection from rain, but it also presents the most wind resistance, making it difficult to hang on to in a gale. Despite being wrenched from WIRED's hands, it remained undamaged. Fulton attributes this to its polycarbonate joints and flexible fibreglass ribs. **8/10** *£40 fulton umbrellas.com* **Diameter** 131cm **Length** 100cm **Weight** 878g

GUST BUSTERS

Five umbrellas, two wind machines, one battered tester

HOW WE TESTED
We put the aerodynamic claims of five umbrellas to the test with help from Agog Special Effects' powerful weather simulators. By using two giant fans, WIRED subjected itself to a buffeting of 74kph, or gale force eight on the Beaufort wind force scale, to see which failed. We also compared their drag coefficient by measuring the force exerted. ***agogspecialeffects.co.uk***









2. KISHA CHEROKEE TRIBE
This smart umbrella connects via Bluetooth to a smartphone and can alert you if you leave it on the bus. Its companion app will also suggest you take the brolly with you if rain is forecast. The smooth opening mechanism and 16-spoke span are impressive, and it maintained its shape in gale conditions. It is rather heavy, though, and the high drag coefficient almost toppled WIRED over. **6/10** *$99 get kisha.com* **D** 108cm **L** 92cm **W** 715g

3. SAMSONITE RAIN PRO
Samsonite makes no claims about wind resistance, but the affordable Rain Pro is a good example of stick-and-hook umbrella design. Sure enough, it failed in our wind test, turning inside out at a wind speed of 63kph. However, it recovered well with no sustaining damage. WIRED appreciated its swift spring-loaded opening mechanism and lightweight design. **5/10** *£16 samsonite.co.uk* **D** 104cm **L** 87cm **W** 405g

4. SENZ° ORIGINAL
The innovative senz° has shorter struts at the front to give you a better forward view and extended struts at the back to keep the rain from your heels. But it's the improved aerodynamics that made this streamlined umbrella sail through our wind test. The elegant folding mechanism and stylish colour options are further evidence of top-quality umbrella design. **9/10** *€55 senz.com* **D** 90cm **L** 79cm **W** 440g

5. BLUNT LITE
The Blunt is so called because its six spokes end in an arc of plastic rather than a point, eliminating the possibility of painful pokes. It also distributes tension around the canopy evenly, lending it extra resilience. It didn't measure up to its claimed force-ten wind resistance, though, turning inside-out during a 67kph gust. To its credit, the fibreglass frame snapped back into shape without damage. **7/10** *£48 bluntumbrellas.com* **D** 103cm **L** 76cm **W** 470g

The h-tron has a 90kW electric motor on the front axle and another on the rear axle with an output of 140kW

AUTOPIA



AUDI H-TRON QUATTRO

With a zero-emission hydrogen fuel cell offering a predicted range of 500 kilometres and full refuelling in just four minutes, Audi's h-tron concept car offers eco-friendly driving without the compromise of the half-hour wait for an electric recharge. An additional lithium-ion battery boosts the h-tron up to 282hp for short surges, translating to 0-100kph in 7.9 seconds and a top speed of 180kph. *£tbc audi.co.uk*

WORDS: JIM HILL; JEREMY WHITE. PHOTOGRAPHY: MITCH PAYNE; ROGER STILLMAN; CHRIS HOARE



DAVID ADJAYE FOR KNOLL WASHINGTON SKELETON CHAIR

Constructed from three separately cast pieces of aluminium, the Knoll Washington chair is fixed together using mortise and tenon joints with stainless-steel fasteners. This creates a combination of propping and balancing struts to support the cantilevered geometric lattice seat. Six finishes are available: copper, nickel, green, grey, white and black. *£1,668 nest.co.uk*

Looking for that personal touch? The designer's signature can be found under the 44cm-high seat

SKELETAL CHIC

WIRED looks at design's bare bones with this selection of structural gear

1. RADO TRUE THINLINE SKELETON
Limited to a run of 99, the Skeleton watch is cased in polished black ceramic with a sandblasted titanium caseback. Semicircular cutouts on the face allow the wearer to view the movement inside. It also boasts a 42-hour power reserve. What is most impressive, though, is that all this is achieved in a watch with a silhouette of just 7mm. *£3,740 rado.com*

2. O SIX HUNDRED KAYAK
Copying the 4,000-year-old design of the traditional Inuit kayak – but swapping the stretched animal skin for translucent carbon fabric – the O Six Hundred kayak weighs in at just 10kg. Its easy-to-construct frame is made from 42 precision cut marine-ply ribs, with cedar spines for lateral strength. *AU $2,000 osixhundred.com*

3. POSTLER-FERGUSON BUOY LAMPS
The London-based design studio looks to the sea for inspiration with this range of three industrial-engineering-themed lamps. Each of the "buoys" is constructed from jet-cut plywood ribs held together by tensioned rope, with a neon bulb at the centre. They range from a table-top-sized 50cm tall task illuminator to a 190cm-high feature light. *£poa postler ferguson.com*

4. TAL ENGEL OTAKU BATHTUB
Inspired by the construction technique of traditional Vietnamese boat-builders, the Otaku tub is woven together from strips of white ash and maple veneer. Placed on a mould and steamed into shape, a resin coating keeps your bathwater in place. An open frame, made from powder-coated steel, suspends the wooden lattice while showing off the patterning. *£poa talengel.com*

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4



WORDS: KATHRYN NAVE. PHOTOGRAPHY: MITCH PAYNE



WIRED MONEY

Together with BBVA

23.06.16

WIRED'S ONE-DAY EVENT UNPICKING THE TECHNOLOGIES, BUSINESSES AND PEOPLE IMPACTING MONEY, BANKING AND FINANCE RETURNS FOR ITS FOURTH YEAR. JOIN US AND MEET THE THINKERS, MAKERS AND DOERS DISRUPTING THE SECTOR

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BAIJU BHATT
Bhatt's Robinhood allows users to trade stocks for free. It has secured £47 million of investment over three rounds of funding.



KATHRYN PETRALIA
Petralia's Kabbage offers capital to people who sell online – from jewellery on Etsy to iPhone cases on eBay.



JONATHAN MEDVED
Medved founded OurCrowd, an Israeli crowdfunding platform for startups, which often raises millions of dollars.



ANTHONY THOMSON
Thomson is the founder of Atom, a digital bank that aims to provide all the services of a typical bank, via mobile apps.



JP RANGASWAMI
The former chief scientist of Salesforce is now enhancing Deutsche Bank's data quality, controls and strategy.



MARTA KRUPINSKA
Azimo, founded by Krupinska, is a low-cost, fast and safe way to send money across borders to 195 countries.

START UP STAGE PARTNER

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HEALTH | MONEY | 2016 | NEXT GEN | RETAIL | SECURITY | ENERGY



HMC Boudicca can traverse the battlefield (or room) with its remote-controlled hexapodal legs

Print and shoot

Michael Sng hand-builds toy tanks using hundreds of 3D-printed parts >

Michael Sng is a one-man tank factory. The Singapore-based designer hand-built the walking mecha toy Codename: Colossus from 435 3D-printed parts. "I wanted to set it apart from what people think a toy is," says Sng.

A former graphic designer, Sng previously sold Stikfas, a stick-figure toy he co-created, to Hasbro. But after the economic downturn, the toy was discontinued and Sng got a job as a teacher. Colossus started out as a way to learn new skills. "I didn't know a lot of electronics," Sng, 38, says. "I learned from scratch."

He designed the entire toy as a 3D CAD file, printing each part on a small home UP Plus 2 printer. "It's nearly 60cm tall, but none of the parts is larger than 12cm long," he explains. "They're put together with hundreds of screws." Sng also hand-wired the working legs, guns and lights, and hand-painted each part, including the interior and tiny characters. (The tank's shell conceals a cannon that fires table tennis balls.) The process took 18 months and cost Sng more than $3,000 (£2,070).

Colossus was part passion project, part audition: under the Machination Studios moniker, Sng's conceived a fictional universe for the toys, set in an alternate timeline after the first world war "where air power never happened, and tanks just got bigger and bigger."

After building two Colossus tanks, *HMC Boudicca* (*see previous page*) and *HMC Galahad* (*below*), he's now working on a private commission. But the next hurdle, he says, is finding an efficient way to make more. "The biggest cost is printing," he says. An alternative could be injection moulding with 3D-printed details. But one thing's certain, he laughs: "The next one will be smaller." **OF-W**
machinationstudio.com

435 PARTS LATER...

Sng's second tank, *HMS Galahad*, made its debut at the New York Comic Con in October 2015





ART BY THE LORRY-LOAD

The Truck Art Project is bringing mobile street art to Spain's delivery vehicles

The problem with street art: it's stuck in one place. Jaime Colsa, CEO and founder of Spanish trucking company Palibex, decided to give the façades of his fleet of freighters over to street artists to tour their work around the country. The Truck Art Project drives street art all over Spain. "We want to surprise viewers while they're walking down the street, by bringing art to the neighbourhoods that don't have art galleries or museums," explains Colsa, 44. "It's like a kind of social work,"

Artist Okuda San Miguel, for instance, painted both sides of a lorry as a "mirage": one side shows a panorama (*above, centre*), the other with three heads looking out. "It's a dialogue between the truck

JAVIER CELLEJA **DANIEL MUÑOZ** SUSO33 **OKUDA SAN MIGUEL** MARINA VARGAS **ABRAHAM LACALLE** JAVIER ARCE















The Truck Art Project is launching a geolocation tool so you can track individual moving artworks' progress across Spain

and the world, he says. "My artwork will take a look at different landscapes around the country."

Since the project's launch in Madrid in November 2015, The Truck Art Project has helped seven Spanish artists paint canvases on ten lorries, each up to 13 metres long by 2.8 metres wide. "It forced me to understand the artwork surface in a new way," explains artist Daniel Muñoz. "It's like drawing in 3D."

Colsa partners with two art curators and personally covers the costs of the makeovers – about €20,000 (£15,000) per lorry, including the artists' fees. He's also planning to refit trucks for use as mobile cinemas and venues to host photographic exhibitions or music events. With ambitions of a fleet of 100 mobile art creations, Colsa is currently looking for sponsors to extend the project outside Spain and his company. "If we paint 50 lorries from every other company's fleet instead of painting all of Palibex's, the art will go everywhere," he says. "It's just a question of sharing." Let them truckers roll, 10-4. **Pauline Bock**

truck-art-project.com

Digital extra!
Download the WIRED app to see more from The Truck Art Project



TECH NEWS WITH REAL IMPACT

Ars Technica, founded in 1998, is the world's most influential technology website and community, providing deep analysis and impartial reporting of the confluence of science, technology, policy, and the Internet.

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"As a ballerina, I've always been interested in the body," says London-based McRae (*below*)

PHOTOGRAPHY: JULIAN LOVE

This artist defies gravity

Lucy McRae bridges science and art in surreal ways – whether wrapping audiences in foil or defying Newtonian laws

As a self-described "science-fiction artist", Lucy McRae transports you into a surreal future, using short films and live installations that examine real scientific subjects – cloning, genetics, space flight – and explore their implications.

Take her recent *Future Day Spa* project. Originally designed to mimic preparation for space flight, the installation let audiences lie on a spa-treatment table before being wrapped in a plastic-foil membrane. The foil was then vacuum sealed until skintight – sending fresh oxygen to the lower body and giving the "patient" a sensation of intimacy.

"I'm very interested in biotechnology, in architecture," says McRae. "It starts with a curiosity into something I don't know about." Her work ranges from design fictions – a perfume pill that secretes scent through pores; chlorophyll skin; a bio-bakery – to fashion and music videos for artists such as Robyn.

Her work can have a profound effect: "One *Future Day Spa* participant said to me, 'I don't choose to have contact with people. This feels like I'm being embraced," recalls McRae, 37. "At the end of the treatment, he sat up and hugged me." The experience inspired McRae to research the phenomenon of isolation, and the impact of art on her audience. "Can these dummy creations that I do in the gallery have actual, plausible scientific extensions?"

In June, McRae will debut her latest film, *The Institute of Isolation*, at the Science Museum in London. The film – and an accompanying live performance – will explore "the evolutionary consequences of gene therapy, and CRISPR". Interviews with scientists intersperse with McRae's creations: "I'm building an anti-gravity machine," she laughs. Its design, she says, is still being developed – McRae's art, like science, "is always evolving." **OF-W** *lucymcrae.net*



Let there be light projections

From Vatican City to the Empire State Building, Obscura Digital delivers unmissable messages

The Empire State Building, Sheikh Zayed Grand Mosque, The Vatican: Obscura Digital turns landmarks into canvases for art and activism on an epic scale. "We're using an interesting medium in a unique way – to get massive impact," says Chris Lejeune, CEO and co-founder of the San Francisco-based design company. Founded in 2000 by Lejeune and creative director Travis Threlkel, Obscura has pioneered projection mapping for years, creating attention-grabbing projects for companies such as Nike, Google and Nasa. But recently, it's pivoted into using the technique for political messaging, particularly around climate change. The Empire State project, *Projecting Change*, was a partnership with the film-maker Louie Psihoyos for his film *Racing Extinction*. "There's a particular statement behind using a building like the Empire State as it pertains to capitalism and the environment," says Lejeune. "It's not so much about the medium, as what the message is." The piece took two years of planning and negotiations. "We wouldn't take no for an answer."

Above: Obscura Digital gets its message across at the Vatican

Creating such massive artworks requires an equally large-scale set-up: *Projecting Change* took 40 carefully positioned 20,000-lumen projectors to create a 33-storey 5K image. "We create a lot of hardware and software innovation," says Lejeune. It also requires unique access – for example, in December 2015, convincing the archbishop of Rome to let Obscura's team inside the Vatican. "We were inside catacombs that people had not been inside before, going up to laser scan the façade of St Peter's basilica," he says. Lejeune estimates one billion people have seen the two projects either directly or online.

"We want this to become a movement," Lejeune says. As such, the company is working with governments and charities on local issues. It's using bigger canvases, too, including an architectural façade for a concert hall in China. "We're looking beyond buildings at natural landscapes – what could it be to project on a mountain, or a desert?" And Obscura's dream? "A Moon shot," he says. After all, it's already seen that dreaming big pays. **OF-W** *obscuradigital.com*

Digital extra!
Download the WIRED app to watch a video of Obscura Digital's work

PHOTOGRAPHY: JOSHUA BROTT; HEIDI DE GIER



Taking place at St Peter's Square in Vatican City, ***Fiat Lux: Illuminating Our Common Home*** brought to life the Pope's concerns over climate change. Fifty high-lumen projectors were used to display images of endangered species to a crowd of 200,000 people.



FOOD ON THE BRAIN

Marije Vogelzang is redesigning the way we eat

Nothing gets closer to the soul than food, says Marije Vogelzang. From her Dordrecht studio, the Dutch food designer subverts the conventions that surround eating. "Food is so incorporated into our lives that we don't see it," says Vogelzang, 37.

Her mission: to make it visible again. She has harnessed the rise of foodie-ism and design thinking to pioneer the field of food design.

"There are many possibilities where designers can link food and eating," she says. Early projects included artworks such as *Eat Love Budapest*, in which Roma women fed visitors one-on-one while telling their life stories. She's opened restaurants and worked with hospitals to improve patient nutrition by changing the food presentation.

In 2014, she started the first undergraduate programme in food design at the Design Academy in Eindhoven, with a syllabus that includes plating aesthetics, psychology, food politics and food production.

Her latest project is called *Plant Bones*. "It's a future scenario where plants are merged with meat." Exhibited at Paris Design Week in 2015, *Plant Bones* presents a skeleton grown from cellulose. Vegetable matter sprouting off it can be eaten "off the bone".

Vogelzang is now working on a performance involving social care, food and empathy, and a project connecting chicken farmers with designers. And all the time, the artist is pushing her still-emerging specialism. "It is quite new," she says. "We're still finding where the boundaries are."

Jeremy Kingsley
marijevogelzang.nl





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Temple Run has actually been optioned for a film



TEMPLE RUN*

Director:
J.J. Abrams

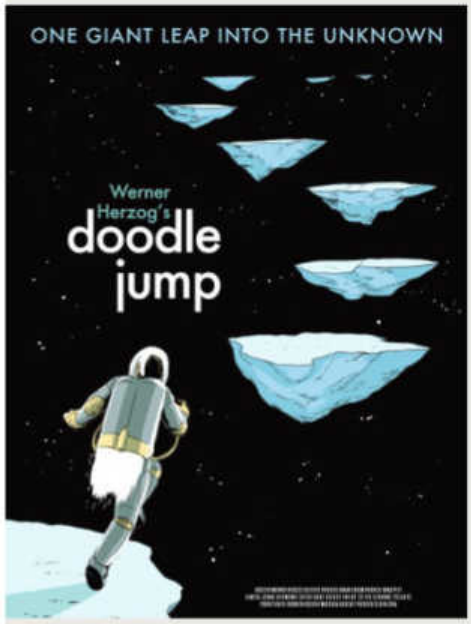
Archaeologist Kentucky Smith (Nicolas Cage) finds himself hunted by Islamic State after stealing artefacts from a Syrian temple as it's being blown up. Teaming up with an alcoholic spy (Adam Driver), Smith is chased across the Middle East – all a set-up for the sequel, *The Infinite Scrolls*.



FRUIT NINJA

Director:
Jim Jarmusch

Ken Watanabe stars as an ageing shinobi in this claustrophobic arthouse thriller. On the run from the cops, Watanabe's furious Snowflame darts into a Tribeca grocery store before taking the oddly unbothered owner (played by Bill Murray) – hostage. Shots – and watermelons – will fly!



DOODLE JUMP

Director:
Werner Herzog

An alien (a motion-captured Shia LaBeouf) wakes up on a floating rock, with no memory of how he got there. He jumps to the slab above, then to the one above that, and so on, hoping to find a clue to his predicament. A monologue, narrated by the director, has the alien pondering the futility of existence, and of life itself.



MONUMENT VALLEY

Director:
Christopher Nolan

Maisie Williams plays plucky princess Ida in this bravura epic from the master of nonlinear storytelling. Our mute, soul-searching heroine defies the laws of physics and geometry as impossible architecture unravels around her, while being stalked by the creepy and possibly illusory Crow People (all played by Tom Hardy). A mind-bending 70mm celluloid experience to be screened exclusively in specially designed revolving cinemas.

App Store: the movie

Despite public demand, Rovio's *The Angry Birds Movie* lands in cinemas on May 13. The first hit smartphone game to make the leap to the multiplex, it may just prompt a wave of app-based epics. Here are some we really hope don't get green-lit. **Alex Godfrey**



ILLUSTRATION: GUY SHIELD



Sequels? Never. Um...

Harry Potter is back. West End play *The Cursed Child*, which previews this month, picks up the story of the Potter family – despite JK Rowling's insistence that it was done and dusted: "I always planned seven books, and I want to finish on seven books," she said in 2006. It's not the first time the creator of a successful film franchise has given in to more sequels. Here are four other projects that just couldn't let go. PB

STAR WARS

2008 George Lucas declares: "There will definitely be no Episodes VII-IX."
2015 Three years after Lucas sells the franchise to Disney, *Star Wars: The Force Awakens* is released, with two more to follow.
Sell-out 7 years.

PIRATES OF THE CARIBBEAN

2008 "This is the end," says producer Jerry Bruckheimer. "Everything is tied up at the end of this movie."
2011 A fourth instalment, *On Stranger Tides*, is released. (A fifth is due in 2017.)
Sell-out 3 years.

SHERLOCK HOLMES

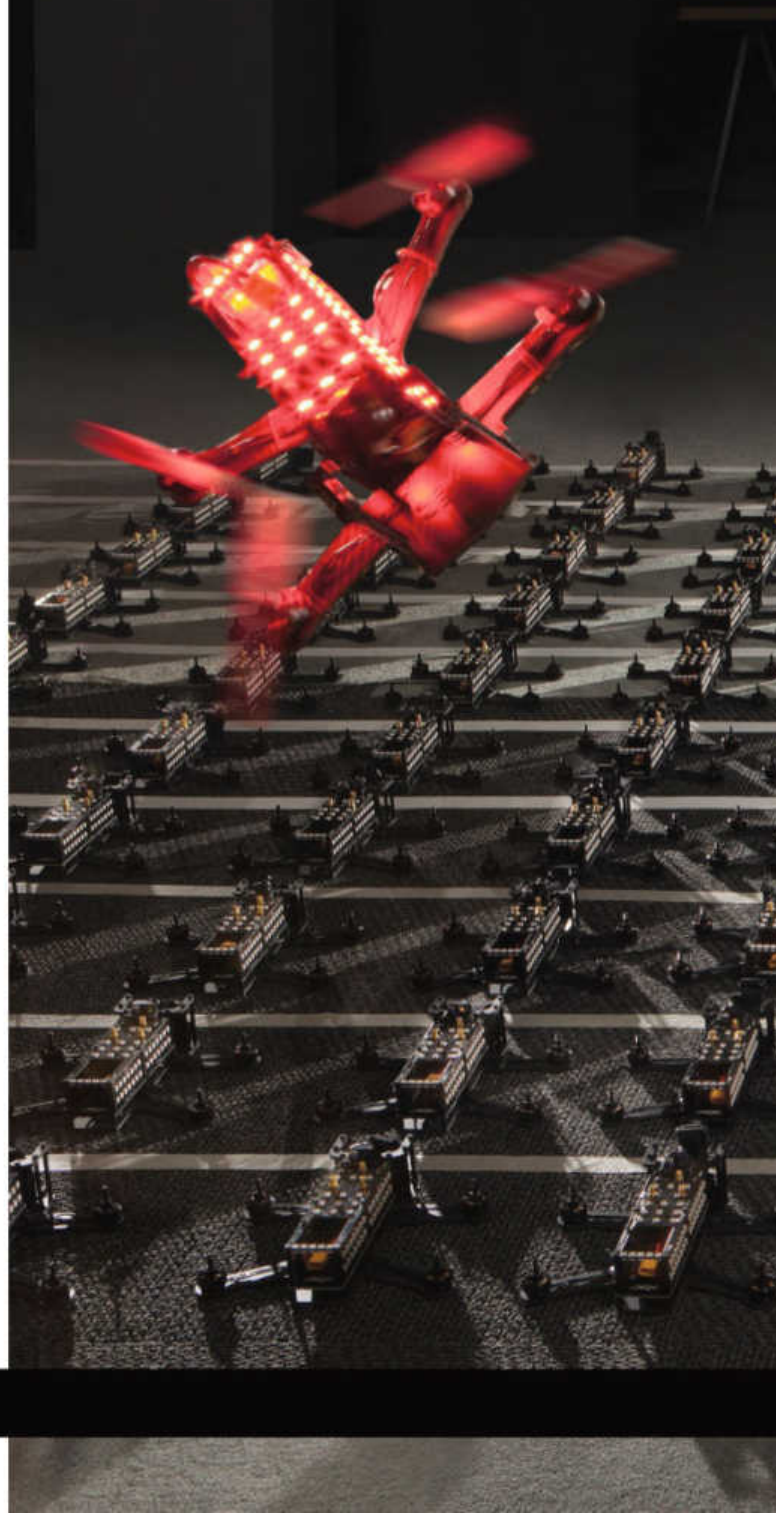
1893 Arthur Conan Doyle makes Holmes plunge to his death in *The Final Problem*.
1901 Conan Doyle writes a prequel, *The Hound of the Baskervilles*, then revives Holmes for *The Adventure of the Empty House*.
Sell-out 8 years.

ROCKY

2008 Sylvester Stallone rules out a sequel to the boxing franchise, joking: "Who am I going to fight, arthritis?"
2015 *Creed*, in which Rocky fights cancer, is released (*Creed II* is currently in production).
Sell-out 7 years.

our quadcopters shriek around the Miami Dolphins stadium at 110kph. The first two, trailing purple and red lights, zip through a glowing LED gate. But the third, lit yellow, mistimes it. The craft collides with the gate strut and smashes into pieces. The commentators go wild; the pilot, FPVProvo, pulls off his virtual-reality headset in disgust. Welcome to the Drone Racing League (DRL), the New York startup which wants to turn quadcopter racing into the next big spectator sport.

DRL CEO Nick Horbaczewski (*pictured*), 35, discovered UAV racing after being introduced by his hobbyist friend Ryan Gury. "He took me out to



PHOTOGRAPHY: JORDAN HOLLENDER. ILLUSTRATION: GIACOMO GAMBINERI

SUPERSTAR UAVS

Nick Horbaczewski wants to make drone racing a global sport

a field in Long Island where a bunch of guys had got together," he says. Horbaczewski, a former chief revenue officer at endurance event Tough Mudder, immediately saw the potential.

"This is [like] the early days of motor racing, when the only people racing cars were the people building them," says Horbaczewski. "If you look at the sales of components, it's a big movement – thousands of people." DRL's races aren't like your usual maker meet-up: its Racer2 drones, used by all pilots, are custom-built to exacting race specifications. Gury, now chief product officer, built a proprietary radio system (video disconnecting used to be a problem) and LED rigs, which make the drones easier to follow and lend a *Tron*-like aesthetic.

Each drone contains two cameras: one standard definition, which streams live video to the pilots, and one high-definition, used to splice together videos for sharing online. Camera drones and ground cameras film every angle. "We've worked on that a lot," says Horbaczewski. "It's hard to think of another sport that is as three-dimensional, as fast, and in as small a space."

DRL has six races scheduled across the US in 2016. Currently invite-only, it plans to introduce live audiences "and ultimately live broadcast experiences", Horbaczewski says. The company has already raised $8 million (£5.6m) in funding from investors including the owner of the Miami Dolphins and Muse frontman Matt Bellamy (enthusiast alert: Muse's 2015 album was titled *Drones*).

The next step: scaling up and recruiting more pilots. DRL has released an online simulator that lets amateurs try their hands at a course. "We're seeing people posting incredible scores," Horbaczewski says. "Put a drone in their hand and give them a few weeks, they might become a superstar." **OF-W** *thedroneracingleague.com*



Below: the custom-built DRL Racer2 is 255mm wide and has a carbon-fibre chassis and ultra-bright LEDs for extra visibility

AFRICA'S COMIC BOOM

Lagos holds its own **annual Comic-Con;** Kenya held its first NAICCON in 2015

Marvel and DC Comics are all about cinematic universes, but in portraying the real world comics tend to be more geographically constrained. (Seriously, New York, stop hogging heroes.) Thankfully, startups are stepping up. Across Africa particularly, artists and writers are creating heroes who speak to their own experience. Take **Comic Republic, Lagos, Nigeria,** which has made waves with its *Guardian Prime* series, about an African superhero. *The Pack*, by Caribbean-born illustrator Paul Louise-Julie, takes inspiration from Egyptian history. South Africa's *Kwezi*, created by Loyiso Mkize, is a millennial hero who spends as much time tweeting as saving the day. And *Supa Strikas*, a football series also from South Africa, prints 1.4 million copies across 16 countries, and is also an animated series.



Black Panther, introduced in *Captain America: Civil War*, will finally get a standalone film in 2017

The reasons for the new boom are two-fold: firstly, the mainstream comic industry's lack of diversity. Representation has improved in recent years, but it's still limited – **and hasn't converted onto the big screen.** And secondly, social media combined with crowdfunding has made it easy to reach fans around the world. For example: when artist Roye Okupe wants to fund a new episode of his Afrofuturist graphic novel *E.X.O.*, he does it on Kickstarter. And with a continent of stories to be told and an audience to match, traditional publishers might want to take note. **OF-W**

"There was the need to create superheroes that look like people I see around, everyday people, Africans like me," says Comic Republic founder **Jide Martin**

Five books to read:

The Pack by Paul Louise-Julie + ***Kwezi*** by Loyiso Mkize + ***Dungeon Quest*** by Joe Daly + ***E.X.O. – Part One*** by Roye Okupe + ***Guardian Prime*** by Comic Republic



WIRED INSIDER'S PICK OF UPCOMING EVENTS

WIRED MONEY

The fourth WIRED Money event will feature 20 Main Stage speakers, plus a Startup Stage of 18 fast-growing companies re-designing business as usual. Topics will include new insurance formats, security, crowdfunding and investment democratisation.
June 23, 2016
wired.co.uk/money16

WIRED 2016

The flagship WIRED two-day event calls in more than 50 top innovators to speak on music, design, technology, science and more. There will be break-out sessions and the Test Lab exhibition of new exciting products. Be there to discover the evolution of the WIRED world.
November 3-4, 2016
wired.co.uk/16

WIRED2016: NEXT GEN

Our one-day event for young people is now in its third year. WIRED2016: Next Generation is for 12-18-year-olds and aims to inspire tomorrow's leaders and innovators with talks, hands-on workshops and performances from more than 20 personalities across the WIRED network.
November 5, 2016
wired.co.uk/next-gen

BRAIN BAR BUDAPEST

A festival on ethics and technology, Brain Bar asks questions about how humanity can adapt to, or be challenged by, the changing nature of technology. Decision makers, trendsetters and WIRED's Rowland Manthorpe present their arguments.
June 2-4, 2016
brainbarbudapest.hu/program

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PHOTOGRAPHY: SUN LEE

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Compiled by Cleo McGee





1 2
3 4





1/aircharge wireless phone-charging system

This phone case lets you charge your iPhone at the 3,700 UK public venues now using the aircharge system, so you'll never be far from a top-up. The case protects your phone from knocks and dirt, and is available in black or white. The charger itself is small and fits neatly on a desk.
£tbc
air-charge.com

2/Stone Island Green DPM Jacquard plated jacket

Doubling as a shirt and jacket, this camouflage piece is coated in black resin to make it splash proof – as well slick looking. It's arrived just in time for festival season, and we think it's perfect as a daytime windcheater, or as a warming layer for late-night outings.
£475
stoneisland.co.uk

3/adidas Originals NMD_R1 trainer in red, white and blue

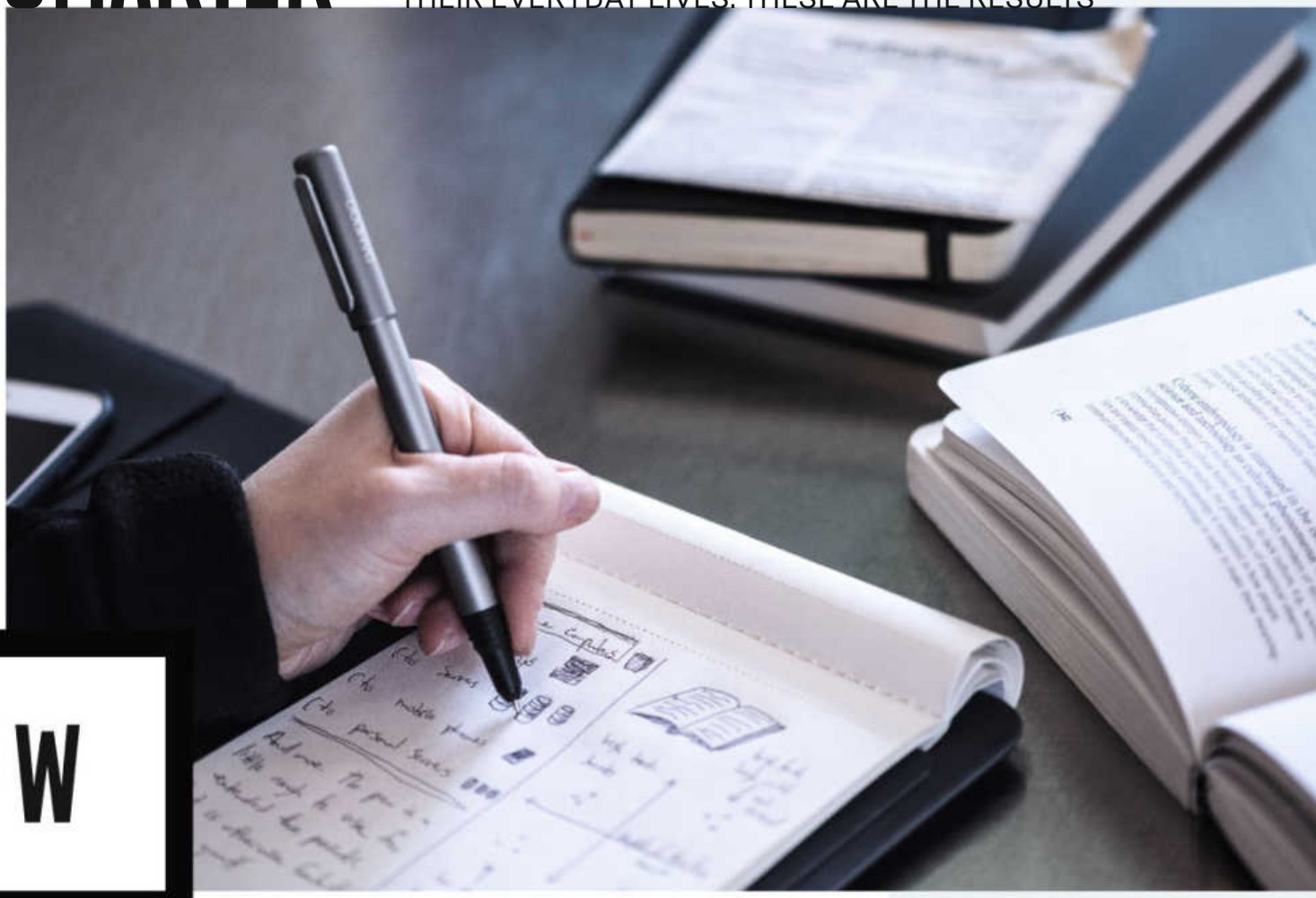
These new adidas kicks are experiencing high demand. Designed to "keep every step charged with an endless supply of light, fast energy," the lightweight build of the shoe means you feel like you are walking on air. Combining style and technology, it's a desirable package.
£130
adidas.co.uk/nmd

4/Burberry Rucksack in technical nylon and leather

This black rucksack features durable nylon gabardine fabric, inspired by Burberry's iconic trench coat. A bag you can take anywhere – from the high street to the highest offices – you can add an extra personal touch by having your initials embroidered on its flank.
£895
uk.burberry.com

WORKING SMARTER

WACOM RECENTLY SENT A BAMBOO SPARK SMART FOLIO TO TEN WIRED READERS TO TEST IN THEIR EVERYDAY LIVES. THESE ARE THE RESULTS



When Wacom wanted to find out how busy, multi-tasking people would work with its new Bamboo Spark smart folio, the company recruited a test panel of WIRED readers to trial the product.

Alex is a 19-year-old natural sciences student. For him, laptops offer easy editing but are limited when it comes to drawing and note-taking. With the Bamboo Spark, he can sketch studies and doodle magnetic fields on paper, which can be transferred to the smart folio. Paper is still the ultimate platform for notes and the Bamboo Spark utilises it – with all the advantages of digital.

"The first syncing experience was very easy, as I was being walked through it, " he says.

Head of a grammar school Design and Technology department, Mark uses Bamboo Spark to create ideas with students and share with the class.

"When I set up the Spark it was incredibly easy and quick," he says.

Alexandra, a chef, aims to create new recipes every day, sketching plate presentations on paper. The Bamboo Spark makes this part of the job a bit easier, more fun and creative.

Interior designer and reflexologist Vanessa calls herself a visual thinker. She uses the smart folio to sketch develop concepts for new interior designs and share these with her clients. She can also add drawings to her notes to better process the information she gets from her customers. ***Wacom.com***

BAMBOO SPARK: THE FEEDBACK



"Studying maths and science-type subjects means my notes involve a lot of maths and diagrams – content very suited to the pen."
Alex, student



"I set up the Bamboo Spark with my iPhone and iPad. And have been backing up all my notes to my computer."
David, research scientist



"In the past I have used a pen and paper to brainstorm ideas, then transfer them by hand onto my iPad. It should be much better using the Spark."
Mark, teacher



MAPPING THE MILLENNIALS

Author Helen Pearson explains how a study of children over their lifetime has built up a bank of data that's helping scientists to better understand disease

GEORGE DAVEY SMITH wants to get his hands on the blood of millennials. To be more specific, he needs to convince several thousand of them, aged around 24, to be weighed, prodded and quizzed, donate blood and urine as well as undergo scans of their livers, hearts, necks and entire bodies. The reason: Davey Smith, an epidemiologist, is leading a study that has been tracking around 14,000 children since birth to understand the many influences on their health and development. And those children are now young adults.

Davey Smith, 57, and his colleagues have already amassed an astonishing biological treasure trove from this group, the Avon Longitudinal study of Parents and Children (ALSPAC). Below his Bristol office, in locked basement storerooms and freezers, lies a macabre bank of samples collected since their births between 1991 and 1992. There are thousands of tufts of hair, nail clippings, milk teeth, umbilical cords, tubes of blood >

ILLUSTRATION: JAN VAN DER VEKEN

The data has been used in more than 1,200 academic papers, including ones showing the benefit of fish during pregnancy, that peanut oil in baby lotions is linked to later peanut allergy and that 15 minutes of exercise a day halves the risk of childhood obesity



plasma and urine. (There are also around 9,000 placentas floating in plastic buckets in a secure storage barn a few kilometres away.) Add to that the reams of data that the scientists have vacuumed up – the participants and their parents have filled in more than 100 questionnaires with enquiries ranging from nappy rash to self-harm to sex – and this makes these millennials some of the most studied people in the world. Their data has been used in more than 1,200 academic papers worldwide, including ones showing the benefits of eating fish during pregnancy, that peanut oil in baby lotions is linked to later peanut allergy, and that 15 minutes of exercise a day halves the risk of childhood obesity. DNA analyses have helped identify genes involved in obesity, eczema, foetal growth, bone density and much more.

This may sound a lot, but the Bristol study is part of a bigger and more unusual enterprise, a remarkable series of birth cohort studies that have tracked successive generations born in Britain. The first of these started when scientists recorded the birth of almost every child born in one week in 1946[1]. Scientists are also following thousands of British children born in 1958, 1970, and the turn of the millennium. There are some 70,000 people in these five studies and no other country has a project quite like it.

In the 40s, the first cohort revealed shocking differences in prenatal care and infant mortality between the working classes and the more well-to-do, which helped shape the fledgling NHS[2]. In later decades, they revealed the link between smoking in pregnancy and infant mortality, helped show the links between foetal development and adult conditions such as heart disease, and revealed how obesity hit Britain in the 80s (more people in the first three cohorts put on weight then).

But in some senses, the studies are only just coming into their own. Davey Smith and his team have made sure that the 90s cohort stays at the forefront in the age of omics and big data. Two thousand cohort members have had their full genome sequenced, and the scientists are now embracing studies of the epigenome, metabolome, transcriptome, microbiome and more. Unlike other such studies, this detailed molecular data can be connected to the wealth of information collected across the participants' lives to try to better understand health and disease. "The sheer amount of this data sets it apart," says Lynn Molloy, executive director of ALSPAC. The power comes in having some of these measurements through time, she explains.

The study has built up maps of epigenetic marks – the chemical marks on DNA that alter the way in which genes behave – across the genomes of thousands of mothers and children. Last year, researchers put that data to use, showing that children of mothers who smoked during pregnancy had a particular pattern of epigenetic marks and that, as the children grew up, some of those marks vanished but some stayed. They hope is to use these types of study to pinpoint the biological mechanisms that connect the two – precisely how the toxins in smoke send genes and cells awry. Researchers around the world are keen to use the data: "We have a clutch of proposals every week," says Nicholas Timpson, a genetic epidemiologist who leads many of the omic studies for ALSPAC.

Data continues to stack up. Around 1,000 cohort members have already attended the latest clinic, Focus @ 24+, which will collect measurements when these young adults are at their physical prime. One aim is to find the early signs of cardiovascular problems[3]. "At this age, you'd expect them to be healthy – and there is not much research on cardiovascular health in this age group," Molloy says. "But we are picking up problems."

Another project will also start this year involving wiring up the bodies and homes of 30 study members with sensors to measure how active they are, and in-house sensors and cameras to monitor eating, sleeping and TV watching. Part of the motivation, says Molloy, is to see whether it's possible to collect data remotely, without members having to give up their time.

Meanwhile, the scientists are doing their best to attract volunteers into the clinic. Timpson says he is always surprised by the commitment of the people involved. "There's a lot of data just because people have given their time, samples and permission. We are stunned at how interested they are in what we're doing."

Helen Pearson is the author of The Life Project *(Allen Lane)*

1. *The 1946 cohort has been followed ever since. In March 2016, the group celebrated turning 70 and being part of the longest continuous, major birth cohort study in the world.*
2. *The data has repeatedly shown that children born into disadvantage often lead more difficult lives than the wealthy. However, interested, involved parents can go some way towards ameliorating these disadvantages.*
3. *The tests of heart and blood vessels include 12 measurements of blood pressure, taken when sitting, standing and exercising. The participants also wear an activity monitor for four days.*

THE ILLUSTRATED EXPERIMENT

WHY 3D GAMING MAY BOOST YOUR BRAIN

This month's pioneering project: Dane Clemenson, a neuroscientist, tested whether playing video games could stimulate the hippocampus. He found that tougher games boosted memory after two weeks

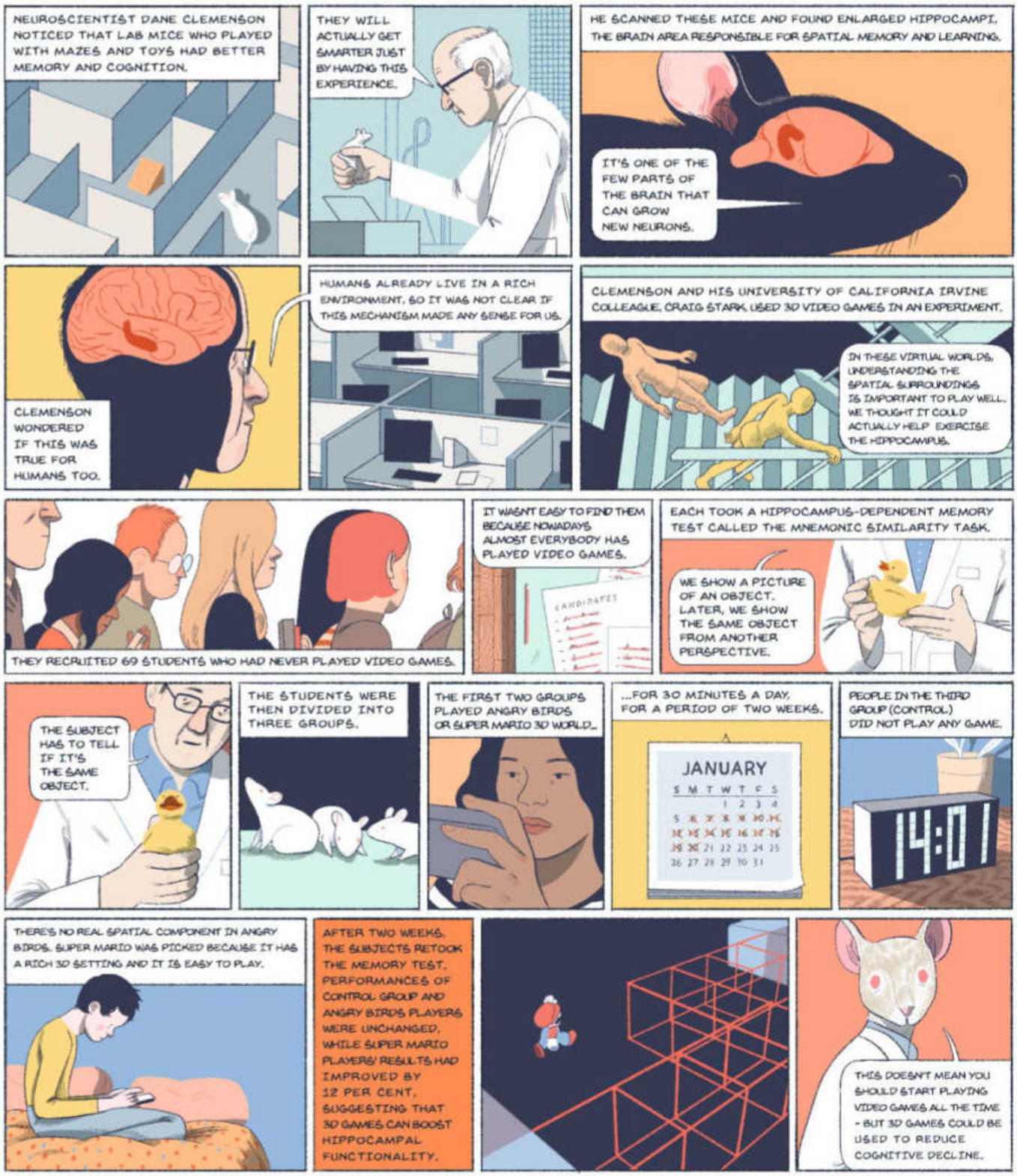


ILLUSTRATION: BIANCA BAGNARELLI. *BUT WITH FOOTNOTES

Q&A

WHY YOU NEED TO DITCH THE DIET FOR YOUR HEALTH

Genetic epidemiologist Tim Spector tells* WIRED *how faddish food regimes are unbalanced and can actually lead you to gain more weight

Tim Spector, a physician and professor of genetic epidemiology at King's College London, wants to debunk healthy-eating mantras. Spector decided to rethink his eating habits after a skiing accident left him with high blood pressure, and to investigate the key role played by gut microbes in maintaining our health. He draws on his research on microbes, genetics and diet to explore our physiological relationship with food, and to investigate how we can nurture a healthy microbiome[1] by eating according to science. Emiko Jozuka

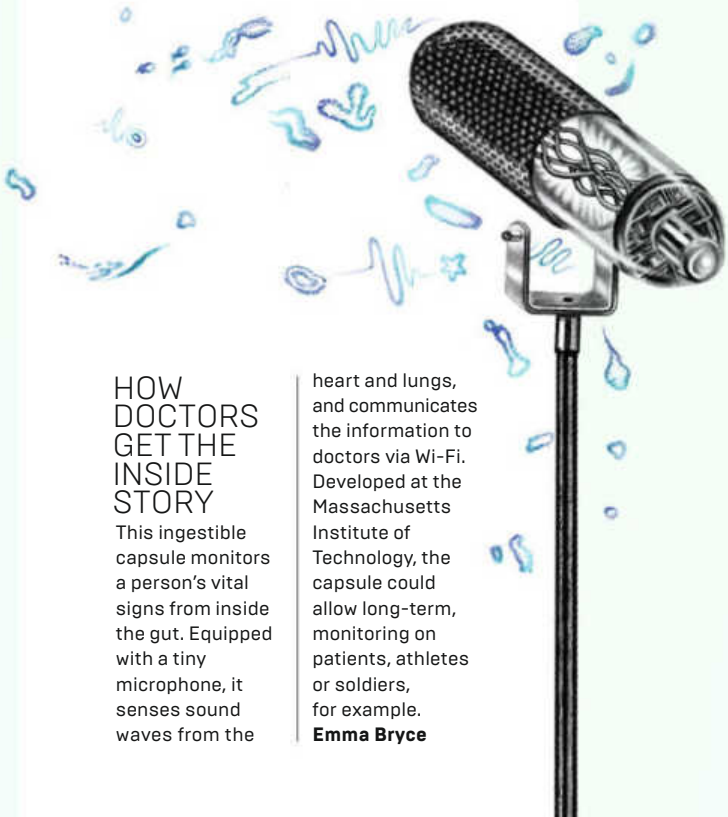
WIRED: In your book *The Diet Myth*, you refer to the "myth of modern diets". What is this?
Tim Spector: There are many myths: the first one states that if everybody follows the same calorie control and does some exercise, then they will lose weight. Another myth states that by restricting and reducing certain items you will lose weight and be healthy. This is the trend of fad diets where people pick on one group of food and avoid others – whether that be gluten, grains, dairy, fat or meat – at all costs. Another fallacy is that grazing rather than gorging is better to maintain our blood glucose levels, and help us lose weight.

Why are myths around food so toxic for our health?
If people have followed advice in the past 30 years, they would have mainly followed low-fat diets – switching from butter to margarine, avoiding nuts and high-fat dairy products like cheese and either selecting low-fat yoghurts or avoiding them completely. The whole idea limits the range of foods that people consume, so that not only do we eat an unbalanced diet with no real nutrition but it is much lower in fibre now than it was 30 or 40 years ago. The artificial sweeteners inside processed foods – which we thought were harmless – also induce our microbes to produce inflammatory and metabolic chemicals that make you more likely to put on weight or get diabetes. It's the double whammy of all the chemicals in these processed foods, plus the lack of fibre that hit our gut microbes hard.

How much do we know about the role microbes play?
We can't live without microbes – they are crucial for the development of our brain and our immune and digestive system. There are an estimated one hundred trillion microbes in our guts. They produce a third of our vitamins and minerals as well as brain chemicals such as serotonin, which are responsible for our mood. If we wipe out our gut microbes then our immune system goes into auto-drive and starts attacking us with autoimmune diseases and allergies. Over millions of years, we've slowly incorporated microbes and worked as a team. In the past few decades, we've been trying to wipe them out – without knowing what we are doing – and this is causing us problems.

What foods should we consume – and why – to maintain a healthy microbiome?
Everybody has a different set of microbes – like a unique microbial fingerprint. At present, we don't know how to personalise in order to help our own microbes. Our studies have shown that you can make animals sick by reducing the diversity of their microbes. So you need to have a diet that increases the diversity of your microbes: that involves avoiding antibiotics, pesticides and chemicals in food and increases your fibre intake as well as its diversity, because for each little change in fruit or vegetable, you've got a whole community of different microbes that will feed off it. Nuts, seeds, dark chocolate, red wine, olive oil and vegetables like leeks, onions, garlic and artichokes are really packed with chemicals that microbes love. This is probably why the Mediterranean diet is the only one that has proven to be beneficial for health. We also need to be regularly consuming more fermented foods such as live yoghurt, kefir, sauerkraut or kimchi as a source of natural microbes.

INGESTIBLES



HOW DOCTORS GET THE INSIDE STORY

This ingestible capsule monitors a person's vital signs from inside the gut. Equipped with a tiny microphone, it senses sound waves from the heart and lungs, and communicates the information to doctors via Wi-Fi. Developed at the Massachusetts Institute of Technology, the capsule could allow long-term, monitoring on patients, athletes or soldiers, for example. **Emma Bryce**

Which dietary principles are backed up by good scientific evidence?
I favour ones that don't interfere with the diversity of what you're eating. So how can you lose weight while keeping your gut microbes healthy? The only diet that does that is intermittent fasting. You can maintain the same things that you eat, but intermittently change the total amount so that a few days out of seven you're consuming only 500 calories. That's the diet that most people stick to – 80 per cent of those who took part in a six-month trial maintained it.

To what extent do our genetics influence our relationship with the foods that we consume?
I used to think that our food choices were driven by what our parents fed us, or the general environment that you were in. So if you came from a southern part of Europe you'd be more likely to like garlic – because you're surrounded by it – than if you live in northern Europe. It turns out that I was wrong: preferences for many of the bitter-tasting foods such as broccoli, sprouts, ginger and garlic are genetically determined. Nearly all the things we looked at in our study on twins[2] had some genetic influence as well as a cultural one. There's even a genetic basis for how much you like junk food. Some of this may be related to our very different gut microbes.

What are you researching next?
I'm interested in identifying the specific microbes that are associated with various diseases, and then working out what foods we need to tailor our diet and improve these microbes and self-medicate with them.

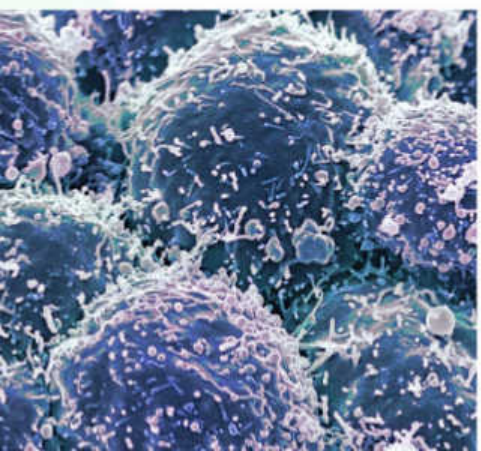


ILLUSTRATION: ANNA PAN; ARMANDO VEVE

1. *The microbiome refers to the trillions of microbes and other bacteria that live inside our bodies.*
2. *In 2014, Spector published a study in* Cell Press *comparing the microbiotas across over 1,000 fecal samples obtained from 416 pairs of twins.*

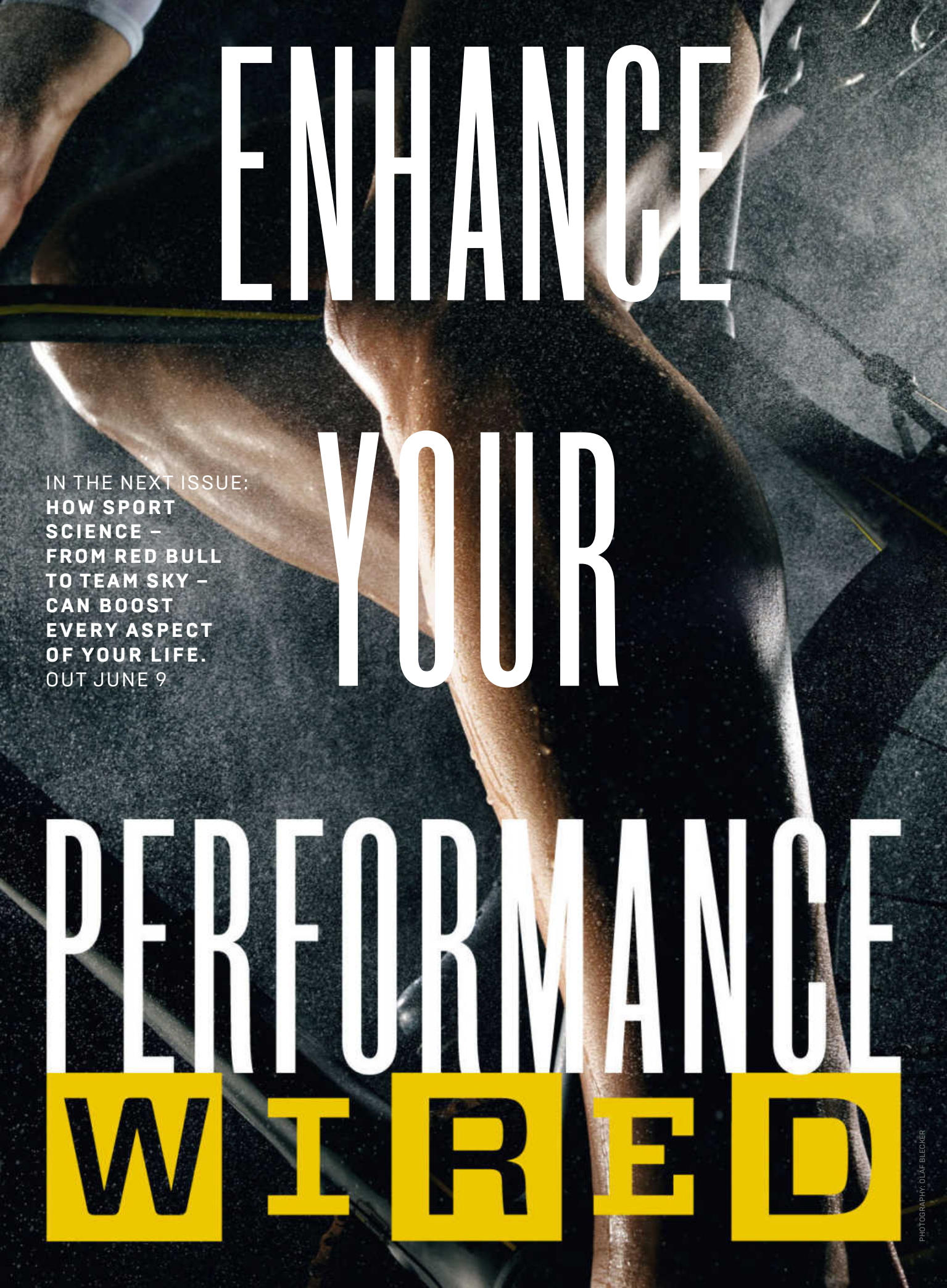
BIOPHYSICS

LASER BEAMS CAN DETERMINE THE STRENGTH OF CANCER CELLS



When Claudia Mierke started to study cancer cells, she decided to do so from a different angle: by applying physics to medical biology. A biophysicist at the University of Leipzig, Germany, Mierke can determine whether a cancer cell will metastasise by studying its physical properties, a discovery that could guide diagnostics and therapy decisions. "We found that invasive cancer cells, which are very aggressive, can decrease the stiffness of blood vessel cells," says Mierke, 43. "That may explain how they migrate in the body."

The study investigates the process of cancer metastasis and how it is connected to the mechanical properties of cancer cells, she explains. The mechanics of single cells are measured by putting the cells in suspension and trapping them in two laser beams. Increasing the laser power stretches the cells, which provides information on the cell's invasiveness: highly deformable cells don't invade as numerously and deeply as stiffer ones. Only breast-cancer and lung-cancer cells have been tested in the study. "After surgery, if we know the cancer cells that are left are not aggressive, it could prevent radiation therapy," Mierke says.
Pauline Bock



IN THE NEXT ISSUE:
HOW SPORT SCIENCE – FROM RED BULL TO TEAM SKY – CAN BOOST EVERY ASPECT OF YOUR LIFE.
OUT JUNE 9

PHOTOGRAPHY: OLAF BLECKER

FEATURES



SET DESIGN: CARRIE LOUISE. PHOTOGRAPHY: BENEDICT MORGAN. COMPOSED USING FOUND OBJECTS IN THE PHOTOGRAPHER'S STUDIO, FROM HIGH-END LUXURY MATERIALS TO EVERYDAY HOUSEHOLD ITEMS

"Short-term profit maximisation has been mistakenly equated with shareholder value." Julie Hanna, p92


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PROFIT OR PURPOSE? YOU CAN HAVE BOTH

DOES THE WORLD NEED ANOTHER LAUNDRY OR FOOD-DELIVERY APP WHEN STARTUPS COULD BE SOLVING SO MANY GENUINE PROBLEMS? FROM KICKSTARTER TO KIVA, LITTLEBITS TO COSMETHICS, FOR-PROFIT COMPANIES ARE GROWING AS NEVER BEFORE BY TARGETING SOCIAL IMPACT WITH A COMMERCIAL MINDSET. SMART ENTREPRENEURS ARE BUILDING SUCCESSFUL, HIGH-REVENUE BUSINESSES BY ADDRESSING EDUCATION, NUTRITION, HEALTHCARE, EVEN EYE-WEAR MANUFACTURE, IN CREATIVE NEW WAYS. WIRED CELEBRATES THE MISSION-DRIVEN FOUNDERS PROVING THAT PURPOSE CAN BE SYNONYMOUS WITH PROFIT.

INTRODUCTION

JULIE HANNA

The executive chair of Kiva and US presidential ambassador for global entrepreneurship argues that deciding between purpose and profit is a false choice

Mike was a top executive in Silicon Valley and attracting him to peer-to-peer online lending firm Kiva, where I'm executive chair, was a really long shot. It meant enticing him to walk away from a coveted, high-profile position and to take a massive pay cut.

Which is why I was both thrilled and stunned when he decided to take the job. But it was what he said when he joined Kiva that really got my attention: what counted most was work that actually mattered.

Far from being the exception, Mike has become the norm. I've mentored dozens of rising stars in Silicon Valley who have turned down or left high-paying jobs for positions that paid less and were far more uncertain. They made the move because they wanted a shot at changing the world and work that was worthy of their lives.

Isn't making a business succeed hard enough on its own? Why saddle it with lofty aspirations of changing the world, social responsibility, environmental stewardship, employee satisfaction, community and other niceties that are ancillary and not directly tied to the bottom line? Nobel Prize-winning economist Milton Friedman argued that "there is one and only one social responsibility of business – to use its resources and engage in activities designed to increase its profits."

The compellingly simple algorithm of maximising profits and shareholder value has been the prevailing conventional wisdom ever since. Full stop. As the time-horizon for measuring profits has shrunk to a myopic focus on quarterly earnings, our modern-day interpretation of Friedman's theory is one he himself might not recognise.

Were he alive, what might Friedman say about the widening gap between his theory and a reality that includes a global economy brought to its knees by short-term profit maximisation that enriches shareholders to the exclusion of any other group, extracting more value from the economy than it creates?

While appealing in its simplicity, short-term profit maximisation has been mistakenly equated with creating shareholder value and often comes at the expense of sustainable value creation for shareholders and stakeholders alike. In February 2016, BlackRock CEO Larry Fink, the world's largest investor with $4.6 trillion in assets, called out the short-termism bug in this prevailing algorithm. He declared that "Today's culture of quarterly earnings hysteria is totally contrary to the long-term approach we need." The global economic crisis of 2008, a sluggish recovery since, pollution, an escalating climate crisis and growing income inequality are ubiquitous and undeniable evidence that the pursuit of profit maximisation at any cost has come at a great cost to the planet and to our humanity.

Millennials are the canaries in the coal mine for much of what ails our way of life and work. Saddled with student debt, they are unable to find work at twice the rate of those over 30 years old; twice as many live in poverty as in the 70s. The unstable nature of the world they are inheriting – and the knowledge that many of them will not share the opportunities their parents had – has led them towards an existential crisis. In the UK, millennials' average disposable income is just a third of that of pensioners, with home ownership a distant dream. >



PREVIOUS SPREAD: [PRINT] ANTHONY BURRILL FOR WIRED. PHOTOGRAPHY: CHARLIE SURBEY

Julie Hanna: "Great companies aren't great because they make lots of money. They make lots of money precisely because they're great"

‘ FOR MILLENNIALS, THE IDEA OF GOING TO WORK WITH THE SINGULAR GOAL OF MAXIMISING PROFITS AND SHAREHOLDER VALUE IS POINTLESS AND ABHORRENT ’

As a result, millennials are making explicit our universal hunger and innate desire to contribute to something bigger than ourselves. The most socially and environmentally conscious generation ever, they have become humanity’s conscience and self-correcting mechanism. They insist on a purposeful connection with companies they buy from, work for and invest in. They want to know why a business exists, what it does, how it treats people and the planet. Nine out of ten believe that success should be measured by more than financial performance. For them, the idea of going to work with the singular goal of maximising profits and shareholder value is pointless and abhorrent. They’re willing to put their money where their mouth is: more than half of millennials have ruled out working for an organisation because of its values or standard of conduct. More than half have “chosen not to undertake a task at work because it went against their personal values or ethics”, according to a 2016 Deloitte survey.

That’s a big deal, because they’ve surpassed the baby boomer generation in size and are expected to own $41 trillion in transferred wealth.

They are shaking up the way companies do business, and speaking up about the way we’re working, when it’s not working. A 2013 Gallup poll across 142 countries discovered that only 13 per cent of employees are “engaged”. In the UK, it’s 17 per cent – a staggering revelation that work is a depleting, dispiriting experience for most of us.

And yet, increasing meaning at work remains one of the most potent – and underutilised – ways to increase productivity, engagement, and performance. According to The Energy Project, a consultancy that counts Google among its clients, employees are more than three times as likely to stay in a job, are twice as happy and are more energised when their work is meaningful.

It would be easy to dismiss this as the naïve ideology of youth, were it not for the fact that many of the world’s most successful, admired and enduring companies are purpose-driven. Contrary to conventional wisdom that purpose is a tax on the bottom line, companies such as Dannon Group, Patagonia, Virgin, Starbucks, Southwest Airlines and Whole Foods are demonstrating that purpose-driven enterprises have an inherent market and profit advantage giving them staying power. In Silicon Valley we often talk about mission-driven versus mercenary-driven companies, acknowledging that both can be financially successful. We also know that mission-driven companies that walk the talk tend to be better places to work, breeding an intense sense of loyalty with employees and customers. Conversely, those which style themselves as mission-driven by merely talking the talk leave a trail of cynicism and mistrust in their wake.

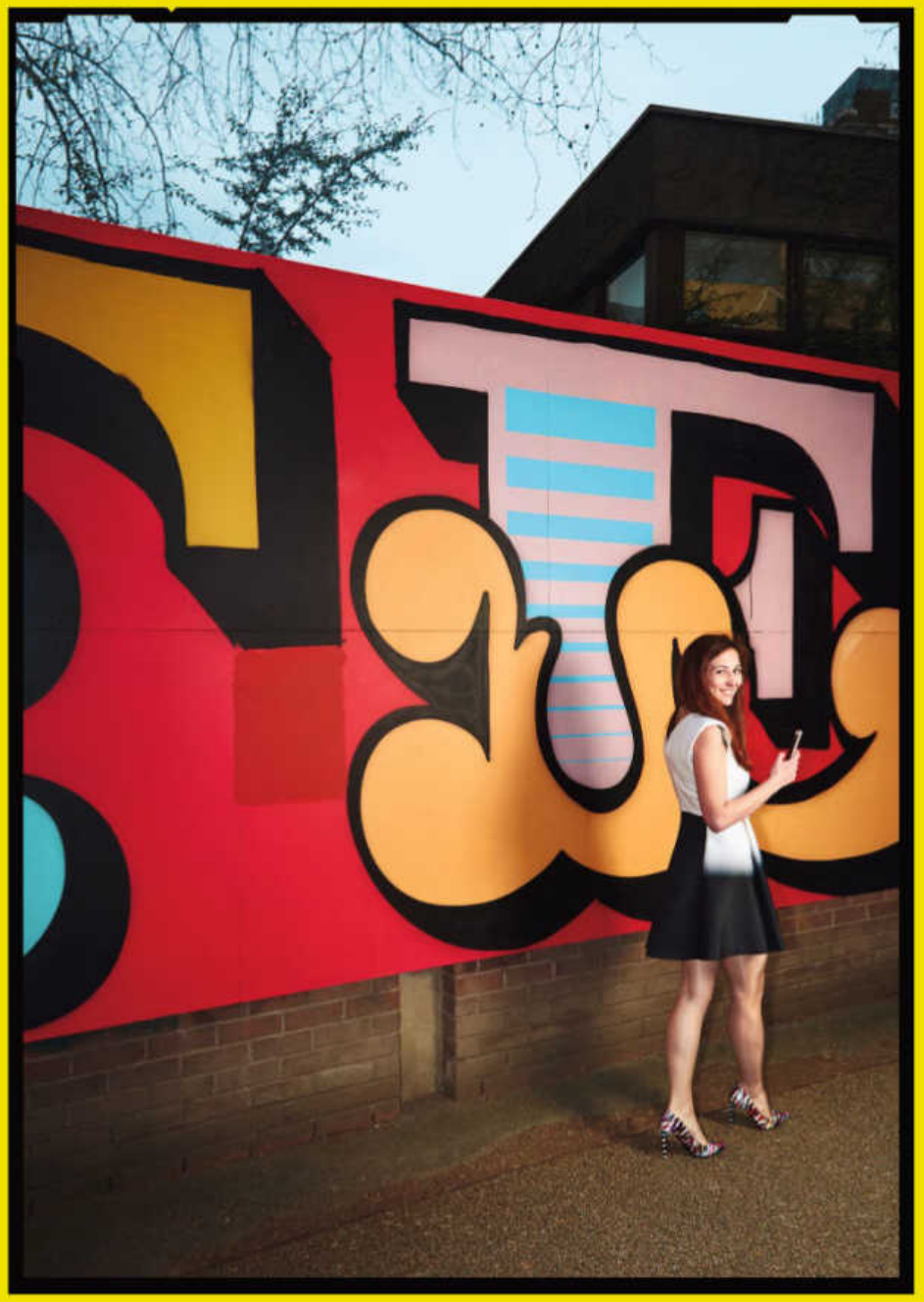
The best entrepreneurs I know are the world’s greatest change agents precisely because they share a native belief that the fundamental purpose of business is purpose. They view profit as essential oxygen to a company’s ability to survive and thrive, and the fuel that maximises their impact. As Kickstarter co-founder and CEO Yancey Strickler puts it, “That’s so obvious, it’s not even a thought. It’s how you find long-term success.”

“If someone gives you a day and tells you to go to the Moon, your only option is to build a ladder,” says Astro Teller, the captain of moonshots at X, formerly Google [x]. His point illustrates how short-term focus does not allow us to solve big problems. “Our goal is to produce as much value for the world as possible. Period,” he says. “Purpose is the point. Profit is the result. It’s the natural order of things. Greater value creation leads to more profit than trying to maximise profit as an endgame.” Citing Google’s annual economic report as an example, Tim O’Reilly, founder of O’Reilly Media and the Next: Economy Summit, a conference on technology and the future of work, iteratively talks about “companies creating more value than they extract”.

Profit and purpose are force multipliers that reinforce each other. Two synergistic halves of a whole where the sum is greater than the parts. Reid Hoffman, co-founder and executive chairman of LinkedIn, says profit is structurally tied to LinkedIn’s mission to create economic opportunity for every member of the global workforce. Ev Williams, co-founder of Twitter and founder of Medium, unapologetically wants both to change the world and to make money. In his view they are clearly complimentary. “It’s strange that people see them as a dichotomy,” he says. “It’s best if you have both. It would never be satisfying to me to build something that was successful in either of those dimensions, but not both. Profit allows you to reinvest in purpose.” Williams’s co-founder Biz Stone describes Twitter’s purpose as “giving voice to the voiceless” and says that “Top talent is drawn to Silicon Valley because it’s the place where they think they can maximise profit and purpose.”

In Silicon Valley, where the war for top talent is notoriously brutal and professional promiscuity is the accepted norm for career growth and learning, attracting a star like Mike is gold precisely because it has an impact on the bottom line.

Great companies aren’t great just because they make lots of money. They make lots of money precisely because they’re great. This is becoming self-evident now that Mike and the millennials are putting these lofty hopes and ambitions within reach. Imagine a world that understands aligning purpose and profit is the art of business, and that this is the most powerful and authentic expression of free-market capitalism. Imagine a world that unlocks the higher side of our nature because we are working toward a higher purpose that is worthy of our life effort. Imagine a world where businesses compete on being best for the world, and where that is precisely what makes them the best in the world.



PHOTOGRAPHY: JAY BROOKS

CONSUMER INSIGHTS

STREETBEES

Consumer data straight from the source rewards local communities

"There is no other platform that provides you access to data in 87 countries within a week," explains Tugce Bulut (*above*), 34, the founder and CEO of Streetbees, which crowdsources consumer data via its app. "It's like a live search engine." Streetbees' 100,000 active members receive a push notification if their profile and location match a company's data search – for instance, a marketer wants to understand the video habits of 20-year-olds in Argentina. They can submit a reply in exchange for £15. Centralised replies are verified by Streetbees and sent to the client – and that turns local knowledge into cash. The London-based company, which launched in January 2015, has 32 clients, among them Pepsi and L'Oréal. The challenge, Bulut says, is to reach rural areas with poor internet access. "In a couple of years, any data from anywhere in the world will be available within days," she explains. **Pauline Bock** *streetbees.com*



CERTIFICATION

B LAB

If for-purpose business has a figurehead, it is Jay Coen Gilbert, the co-founder of B Lab. Established in 2006 and based in Wayne, Pennsylvania, B Lab certifies for-profit companies as Benefit Corporations, or B Corps. To be certified, companies must meet demanding social and environmental standards, and show that they generate value for society as a whole, not just shareholders. Crucially, they must also adopt corporate governance documents legally obliging their boards to consider social impact. That means the commitment can't be diluted, even if the company changes hands.

Coen Gilbert, 48, co-founded AND1, a multimillion-dollar sportswear company, but was inspired to his mission by events in 2001: within a month, his sister was injured during the 9/11 attack on New York City, his father died of lung cancer, and a work colleague was killed in a car crash.

There are now more than 1,600 certified B Corps in the US, each paying a proportional subscription. Their total revenues are around $28 billion (£19.6bn). Coen Gilbert wants to increase numbers and effect a wholesale change in business. He sees the B Corp not as progressive, but as a revival of traditional American values. "The B Corp idea is a return to relationship-based business," he says. "Old-school values for a new economy." **Richard Benson** *bcorporation.net*



INFRASTRUCTURE

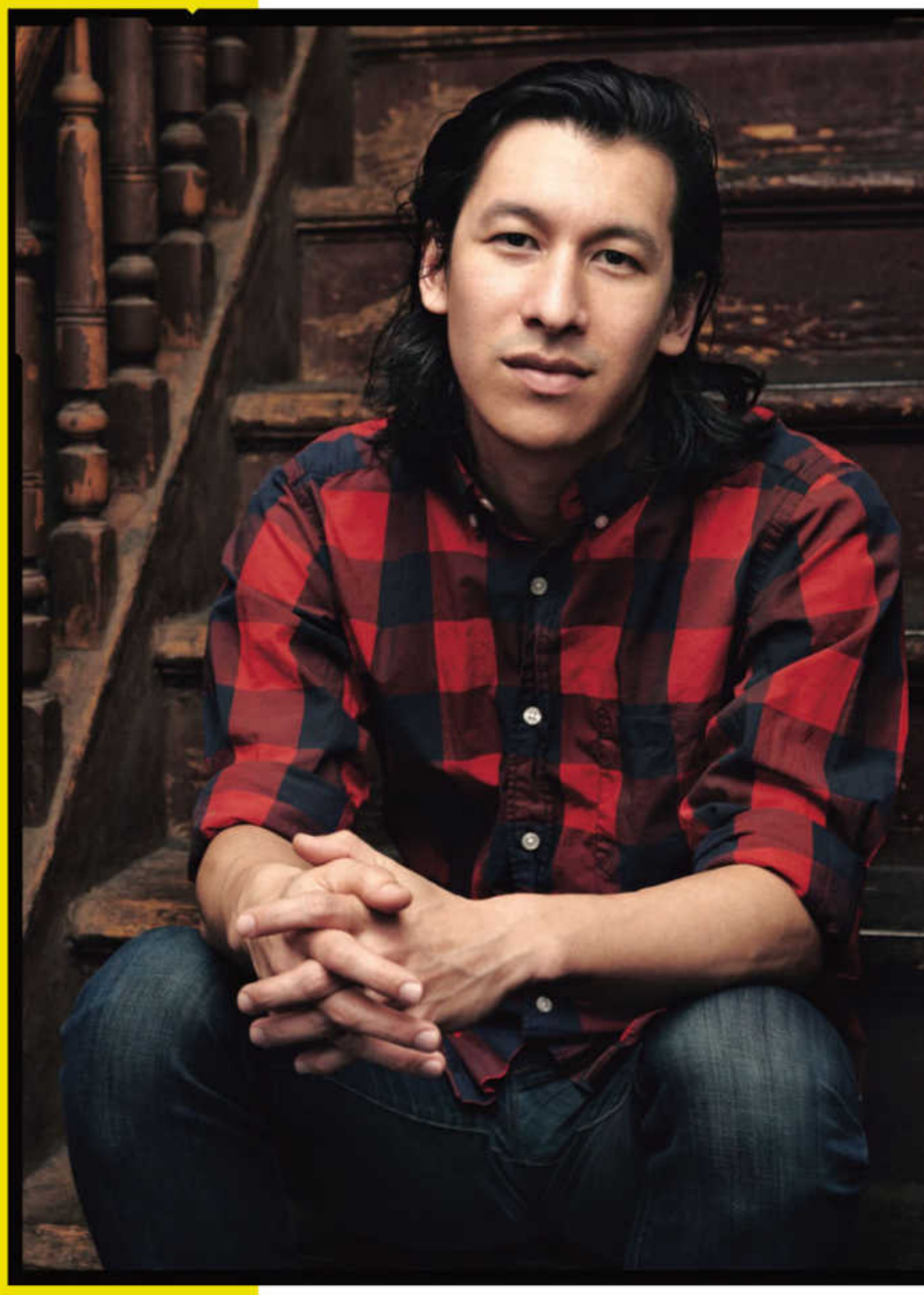
BRCK

In 2013, Juliana Rotich was trying to run an international software company in Nairobi while facing an average of two or three energy blackouts a month. So, together with other members of the crowdsourced information non-profit Ushahidi, she created the BRCK mobile Wi-Fi hub. "My co-founder [BRCK's CEO] Erik Hersman jotted down the idea for a device with an energy store for when the power went out, that could connect to mobile networks and provide a Wi-Fi hub for up to 20 devices," Rotich, 38, explains. "It was a solution for a problem we faced first-hand."

Nearly 60 per cent of the world's population still lacks reliable internet. More than 3,000 of BRCK's $250 (£175) modems have been sold so far in 50 countries.

In 2015, BRCK launched the $5,000 KioKit for classrooms, which packages a BRCK with 40 rugged tablets, encased in a reinforced, waterproof charging case. So far the company has raised $4 million in private funding, in addition to a $170,000 Kickstarter in June 2013, with Ushahidi retaining a stake in the business. "We needed a for-profit set-up so that we could take seed stage investment," Rotich says. "But the structure doesn't change the mission. There are many ways of solving a problem." **Kathryn Nave**
brck.com

Perry Chen, co-founder and chair of Kickstarter: "Profit maximisation is not a mantra we subscribe to"





MEDICINE

AUROLAB

Intraocular lenses are needed to replace the eye's natural lens once cataracts are removed, but can be costly for those in the developing world. Aurolab, based in Madurai, a city in the south of India, aims to "eliminate needless blindness" by offering locals cheap and high-quality ophthalmic lenses. Founded in 1992 by the Aravind Eye Care Hospital with help from entrepreneur David Green and the World Health Organisation, Aurolab is a non-profit charitable trust that produces almost 1.2 million lenses annually, for $2 (£1.43) each, compared to $150 in the developed world. **PB** *aurolab.com*

PHOTOGRAPHY: ROWAN FEE; BJARNE JONASSON/TRUNK ARCHIVE

CROWDFUNDING

KICKSTARTER

A commitment to art, culture and creativity has lead the crowdfunding site to place B Corp thinking at its heart

In September 2015, New York-based Kickstarter was re-incorporated as a public benefit corporation – a for-profit company legally obliged to consider the impact of its decisions on society, not just shareholders. Its charter (kickstarter.com/charter) clarifies how the company will act in situations that are often swayed by profit motives. Commitments include a refusal to sell user data to third parties; a declaration never to campaign for public policies unless they align with its mission and values, regardless of possible economic benefits; a decision not to use "loopholes or other esoteric but legal tax management strategies" to avoid taxes; and a commitment to donating five per cent of its after-tax profit to arts and music education, and to organisations fighting to end systemic inequality. Perry Chen, founder and chairman, explains the company's thinking. ***kickstarter.com***

Having our values be non-negotiable was how we operated even before we knew about public benefit corporations, and it was a big part of how we approached every step, including the investors and employees we chose to work with. So when we went back to shareholders to convert from a straightforward "C" corporation to a benefit corporation, it was no surprise. Our shareholders, including current and former employees as well as investors, joined us in voting to become a benefit corporation, with not a single vote against.

This structure codifies and allows us to clearly articulate who we are. Not just our long-held mission – to help bring creative projects to life – but the values that lead our conduct in that pursuit, and the commitments we make to the people who use our service, to the public, and to each other. The depth of articulation we strove for in our new charter is not required to become a benefit corporation, but it was an unparalleled opportunity to give these beliefs greater permanence by building them into the legal form of the company itself. This is the deepest way we know how to weave these intentions into the fabric of Kickstarter for the long term.

The benefit corporation structure lets us be completely clear that the pursuit of profit will not override our mission and values. Profit maximisation is not a mantra that we subscribe to, or believe builds the best societies. Yes, Kickstarter is a business, but profit is only one of many considerations. It's always been this way, but now it's part of the legal framework of the company.

The Benefit Corporation form has teeth. It sets the tone for conversations with investors and employees, and is critical in pointing everyone in the same direction. It also gives current and future leaders of Kickstarter not only the mandate, but the freedom, to operate to goals beyond profit. Indeed, it goes completely the other way from traditional corporations and makes it a fiduciary obligation for the company's leadership to do so.

Patagonia became a benefit corporation a few years before us, and they led the way with their inspired thinking. My favourite part of Patagonia's charter is: "Patagonia may share proprietary information and best practices with other businesses, including direct competitors, when the board of directors of Patagonia determines that doing so may produce a material positive impact on the environment." It's clear that the environment is Patagonia's North Star.

At Kickstarter, we believe art, culture, and creativity are of the utmost importance. We see a risk of a monoculture. So how do we maintain the vibrancy and diversity of art and culture? We have a worldview – we want a better world, we believe there need to be businesses that are not monolithic and simply treat people as nothing more than data points. Unfortunately, it's standard for a company's "mission" to be a brand statement, rather than their true North Star, and for "values" to be fair-weather, so long as they don't get in the way of profits. There needs to be room for businesses of all sizes to break out of today's rampant profit-maximising paradigm. Otherwise, where are we going?

ENERGY

BUFFALO GRID

Giving African entrepreneurs free electricity can generate profit



London-based Buffalo Grid uses portable, solar-powered charging units to offer a mobile-phone charging service in rural communities in Africa and India. CEO Daniel Becerra, 37 (*left*), says 43-year-old chairman Phil Schluter's background in coffee trading in Africa meant that when the company was in its early stages, Schluter could place chargers at coffee plantations. The charging units cost £400 (£250 per unit, £150 to deploy), but are supplied free to entrepreneurs, who then share the profits with Buffalo Grid. The company also partners with telcos, which cover the cost of free charging to drive greater phone use. And the name? "Well, Phil grew up in Africa," Becerra says, "where you learn that a buffalo will charge anything." **RB** ***buffalogrid.com***

HARDWARE

LITTLEBITS

Ayah Bdeir's electronic building blocks are the foundations of a firm aiming to unleash the inventor in everyone

When littleBits customers first experience their "Aha" moment, their excited feedback jumps through the 100-person company's Chelsea, New York, office via an internal Slack channel called #the-moment.

"When Nasa JPL engineers use Amazon Echo to drive their littleBits-powered Mars Rover..."

"The best investment I've made since my retirement. Just yesterday, I constructed an earthquake warning system – today I will be working on my bushfire and thunderstorm warning system..."

"If I could say how passionate I am about your mission: THIS PASSIONATE! Well, way, way, WAY more than CAPS can ever hope to express..."

littleBits is an open-source kit of electronic modules that snap together with magnets in a way designed to let anyone – children or rocket engineers – prototype or play. The "moment" – when pressure sensors, motion triggers and servo motors are suddenly transformed into magic – is currently being discovered in 3,000 schools, and among 230 local enthusiast communities that the company calls "global chapters". And for founder and CEO Ayah Bdeir, that's all part of her mission: "To unleash the inventor in everyone."

"We're trying to trigger an attitude shift, even a personality change – that moment when someone goes from being afraid or intimated or thinking, 'I'm not technical', to thinking: 'Wow! I made that happen'," Bdeir explains. "Their eyes open up. We have parents writing us love letters – saying my daughter wanted to be a Hollywood actress, now she wants to be an engineer; or entrepreneurs who say we enabled them to prototype their idea and raise money. We want to empower young and old to feel creative, confident and active, and to be inspired and empowered by technology. There's such a big opportunity to build a company that democratises invention."

Bdeir, 33, had a transformative moment of her own. Born in Montreal, she grew up in Beirut, where her curiosity led her to take apart her toys to understand how they worked ("I developed a reputation – don't put your stuff near Ayah or she'll break it open"). Her parents nurtured that curiosity with chemistry sets and electricity kits; but she was also influenced by her three sisters, all designers. These two worlds came together at MIT Media Lab's Computing Culture group. "It was, 'Wow, if you combine design and engineering, that's a very powerful tool.'" After graduating she went on to work in finance, and then became a fellow at New York's Eyebeam art and technology centre, where she had the idea for a modular electronics kit. In 2009, she took a booth at a Bay Area Maker Faire. A queue formed: parents, kids, teachers, designers. "There were hundreds of people. A young girl had been playing with littleBits for hours, and her mother made me pretend I was closing up my booth. I thought, 'There's something really powerful here with education and kids.'"

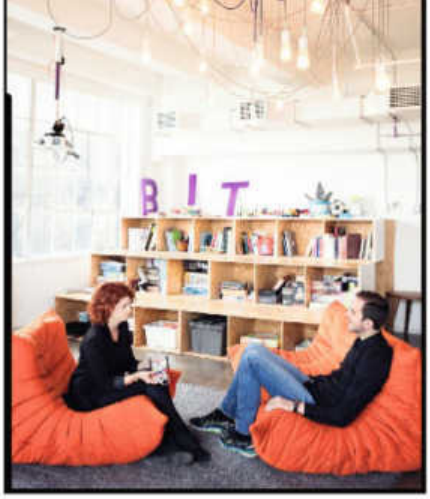
Since then, littleBits has raised around $60m, moved into wholesale distribution to Europe, Asia and beyond, expanded the number and complexity of components, launched a $300 STEAM kit aimed at schools, built a teachers' course, and created after-schools programmes. The company has postponed "optimising for profit" for now, to invest in its continued rapid growth. But this is a proudly for-profit VC-backed business. "Making money is important," says Bdeir. "Money is freedom for a company." And this one happens to be aligned behind a mission.

"That mission has been hugely helpful," she says. "It's attracted to our team people who believe in a higher purpose, beyond profit; people who are empathetic, willing to put in the extra time to make something work; people who otherwise we couldn't afford; people who are not sabotaging each other. If your aim is only profit,



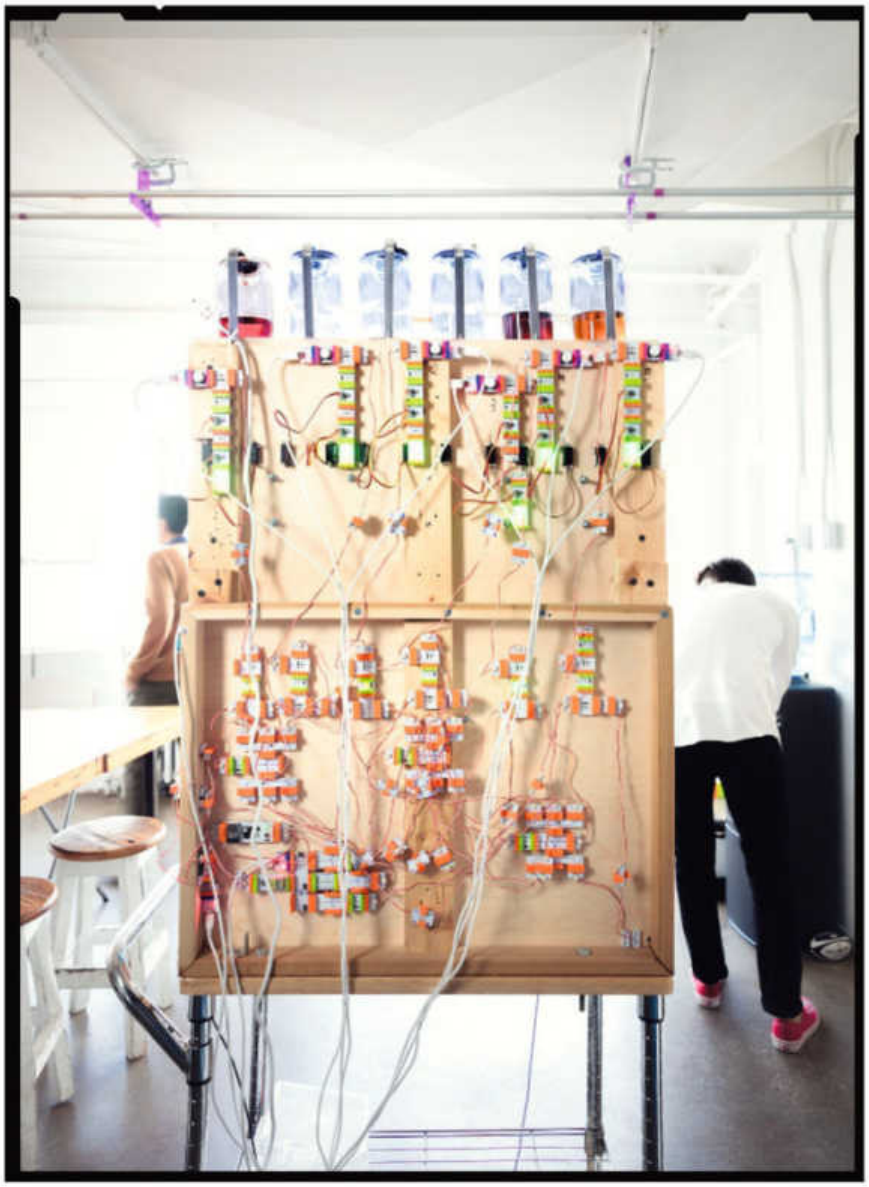
PHOTOGRAPHY: CHRIS CRISMAN

littleBits' founder Ayah Bdeir: "The best-case scenario is when you make a profit and have a purpose at the same time"





Right: littleBits staff in the firm's New York HQ
Below: the rear side of the office drinks-vending machine, built using littleBits components



'TWITTER MEETS FACEBOOK FOR CHICKENS OR WHATEVER... IT'S NOT MEANINGFUL'

that's what you're optimising for. If your aim is mission, you can't screw somebody along the way.

"With a startup, the highs are very high, and the lows are very low – what lifts you up is the mission, seeing the impact of what you're doing. Unless you feel in your blood that what you're creating needs to exist, you will not have enough fuel to take you through."

Is there ever a conflict between profit and mission? "Yes, of course," Bdeir says. "At one point it was a conflict between focusing on keeping retail costs down and building out the profit line. If you're only mission-driven, you'd place dropping costs first to make it more accessible. But early on we had to focus on growth and on appealing to wealthier consumers."

Bdeir worries that too many early-stage entrepreneurs who seek her advice are more interested in starting a company than in what the company is going to do. "They talk of plans to build bizarre mashups of companies – Twitter meets Facebook for chickens, or whatever... It's not meaningful, it's not necessary. Entrepreneurship is now glamorous and sexy, but it's very difficult. Unless you are obsessed by a problem, then you should absolutely not start a company. Some of the smartest people in the world would have so much more impact if they'd join a startup that's solving real problems. Watching the US election campaign, you know the determining factors driving people to vote are some of the most basic unmet needs – around education, healthcare, housing; yet we have some of the most advanced technology available!

"The best-case scenario is when you make a profit *and* have a purpose. It feeds your head, your heart and your pocket. There's no better way to live your life." **David Rowan** *littlebits.cc*

PHOTOGRAPHY: CHRIS CRISMAN

PUBLISHING

MEDIUM

Evan Williams's publishing platform values quality and impactfulness over revenue



Both Evan Williams's entrepreneurial strategy and his social mission could be characterised as "the more voices the better". The theme was first evidenced in his co-founding of one of the earliest blogging tools, Blogger. Then he co-founded Twitter. Now he is CEO of San Francisco-based publishing platform Medium, which hosts both professional writers and open contributions by anyone with an internet connection. The site, founded in 2012, now reaches over 25 million monthly visitors and has raised $82 million (£57m) in funding.

Williams, 44, describes its aim as: "To raise the level of discourse on the internet, and to push ideas forward."

More than that, Williams says it will expand the level of discourse to include a more diverse range of voices, each able to bring a unique perspective on an issue – from outside the traditional media establishment as well as within. On Medium you might find Barack Obama (whose 2015 State of the Union speech was first published here), or an open dialogue between a police officer and a black teenager on police brutality, or personal stories, open letters, activist commentary and first-hand reports of issues such as campus racism and sexism in the workplace.

That anti-hierarchical attitude and an emphasis on diverse opinions permeates the culture within Medium too, with responsibility for shaping the company's direction distributed among all employees. "I think people here feel empowered by the fact that they're working on something meaningful and impactful," Williams says. "It's exciting and energising." **KN** *medium.com*

COMMUNICATION

PIGEONLY



Keeping prisoners in touch with their support networks isn't just profitable – it can cut re-offending rates

rederick Hutson, the softly-spoken 32-year-old co-founder and CEO of Pigeonly, was a businessman before he entered the for-purpose sector; back in the early 2000s he was making $500,000 (£354,000) a year tax-free as a Las Vegas-based drug trafficker. That changed in 2007, when he was busted and served a 51-month prison sentence that offered a fresh arena for his entrepreneurialism.

In jail, Hutson realised that prisoners were cut off from friends and relatives to a greater extent than they needed to be. For example, his fellow inmates were allowed to receive photographs from loved ones. However, email is banned and, as inmates are frequently moved between prisons, it can be difficult to know where prints should be sent. Plus making and posting prints seemed anachronistic.

After being released in 2011, Hutson set up an online service called Fotopigeon. Senders upload photos, adding the intended recipient's name and prisoner number. The company then prints the pictures, locates the inmate, and sends the photos through the post. It currently sends between 150,000 and 200,000 pictures each month, and has $4.8 million (£3.3m) in seed and venture funding.

Pigeonly now also provides a VoIP-based phone service which allows prisoners to make calls at a fraction of the (often heavily gouged) price they would pay on prison phones. In addition, there are services for sending letters and greetings cards, sharing online articles, and an app-based social network for prisoners' partners.

In prison, says Hutson, "Staying in touch with loved ones is a problem because the phone time is so expensive, but I could see there was an answer in smartphone technology. And if you can find a problem you can solve, you have a business."

He now sees his potential market as being not just prisoners, but all of the "overlooked and underserved". As far as convicts go, though, shouldn't isolation be a part of the sentence? "No," he says. "Because prisoners who are isolated are more likely to re-offend. If we want ex-convicts to rejoin society, it makes sense for them to be in touch with their support network." **RB** *pigeon.ly*

EDUCATION



BRIDGE INTERNATIONAL ACADEMIES

School-in-a-box technology has made it possible for more children in the developing world to receive an education

This Nairobi-based startup provides pre-school and primary-level education to 100,000 children in 400 schools and nurseries in developing markets across Africa and Asia. The for-profit was launched by former financial analyst Shannon May and her husband Jay Kimmelman (*above*) in 2009, and has since attracted funding from investors including Mark Zuckerberg, Bill Gates and the Omidyar Network. Besides May's drive, its success is credited to scale and "school-in-a-box" technology: essentially the business is able to offer education for $78 (£55) per year per pupil by training teachers to deliver scripted lessons from tablets. Schools require just one manager, who runs the back-office operations via a smartphone app.

It's about "bringing an urgency and a passion to children's education, coupled with design-thinking driven by data from the classroom," says May, who argues that "will and urgency", not finance, is the limiting factor in education provision. "The focus on building schools is also a distraction. The real issue is making sure learning is happening in the classroom, measuring that, and reacting to what each child needs. Most states have far greater access to capital than Bridge, [but] don't have the benefit of starting from a point of innovation."

Bridge International has been the subject of controversy, with some educators criticising the script-based teaching and training, and others pointing out that total fees tend be a lot higher than Bridge claims. "A strong majority can afford to send all of their children to Bridge," May counters. "Even those living in extreme poverty on less than $1.25 a day can afford to send at least two children." Aside from the cost issue, it's clear that Bridge is increasing educational provision where states have failed. May plans to expand into India later this year, and aims to teach ten million pupils by 2025. **RB**

bridgeinternationalacademies.com

SANITATION

X-RUNNER

Installing waterless systems has transformed the lives of many in water-deprived Peru



Growing up in Switzerland in the 80s and 90s, Jessica Altenburger was a Girl Scout and, on camping trips, often found herself charged with digging latrines. "It taught me all the problems of not having an adequate toilet," she says. "Toilets make a huge difference to lives. Having your own is safer in health terms, and it also gives freedom and boosts confidence."

Altenburger (*near left*), 33, is a co-founder of x-runner, a for-profit that installs waterless toilets in Lima, Peru. The toilets, supplied by Swedish manufacturer Separett, are, effectively, rented; for a $10 monthly subscription, x-runner collects waste and turns it into compost. Lima is the world's second most water-deprived capital city and many of its slum houses share pit latrines. The startup has signed up 500 customers and has broken even in three years. It aims to have 3,000 customers by 2019.

Separett is designed so as to make it desirable as a lifestyle statement. Altenburger says this is important: cheap equipment was used in a previous iteration of the company in India – but was rejected because potential customers thought it indicated poverty. Beyond its appearance, the functionality of the toilet, which separates urine and faeces to reduce smell and toxicity, makes it perfect for high-density urban areas. "Everyone should be separating solids and liquid in waste disposal," Altenburger says. "Historically, westerners have mixed water and urine with faeces to transport to plants in order to separate them again. It doesn't make sense in places where water is scarce." Altenburger and her co-founder Isabel Medem (*far left*) are working with a number of foundations (they also have angel investment) to develop their ideas on rethinking western sewage processing.

In areas where the state struggles, x-runner shows how entrepreneurial innovation can be successful. "Governments are not allowed to take risks," Altenburger says. "We took a huge risk. Somehow, we have managed to make it go right." **RB**

xrunner-venture.com

PHOTOGRAPHY: SPENCER LOWELL



BEAUTY PRODUCTS

COSMETHICS

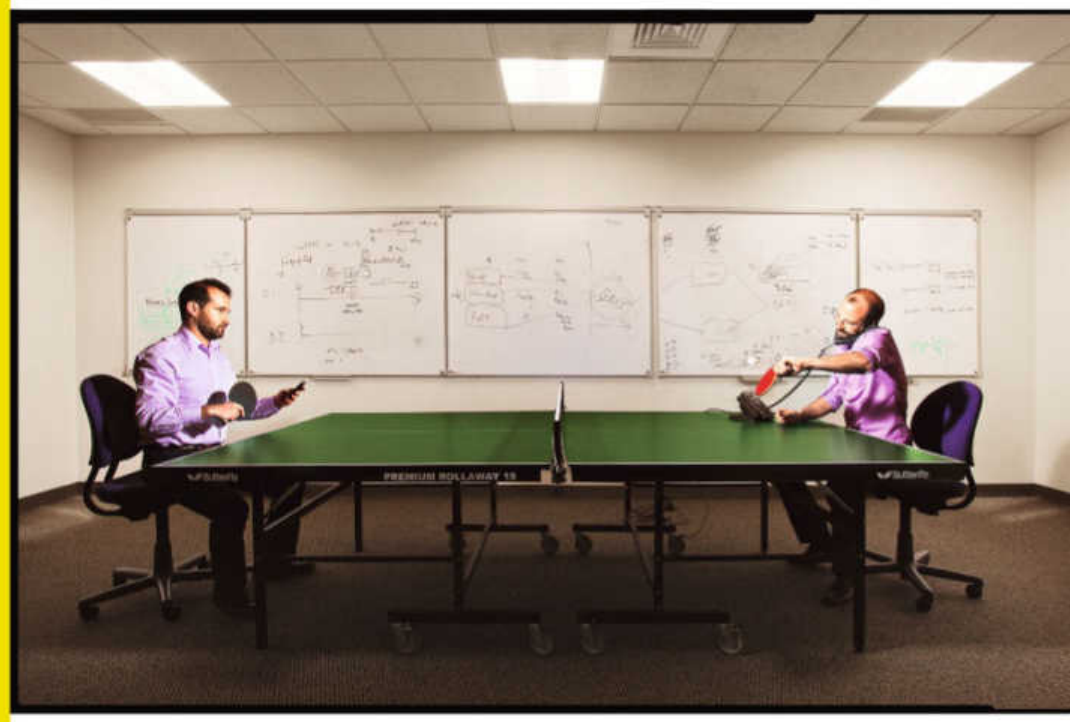
Finding the ideal shade of lipstick or a signature aftershave can be a quest in itself; making sure the product doesn't include parabens and other phthalates can mean negotiating a minefield of harmful ingredients. The *CosmEthics* app makes the process easier – scan a product's barcode with a smartphone camera, and it analyses ingredients from its database of 40,000 products and offers healthier alternatives. "You can set your own alerts for allergies, sensitive skin, veganism and to avoid plastics," says CosmEthics founder and CEO Katariina Rantanen, 37. If the app doesn't know a product, it will ask you to take a photo, which will be analysed by biochemists and added to the system. Push notifications alert the you to any ingredient banned in the EU.

Founded in 2014 and based in Helsinki, CosmEthics has raised €700,000 (£540,000) in seed and government funding and is available in seven languages, including Chinese. "We offer a paying version for department stores, like a super-smart sales assistant that advises customers," Rantanen says. **PB** *cosmethics.com*

ENERGY

OPOWER

Giving more power to consumers is changing how millions of people use energy – and it helps suppliers clean up



Utilities, states Alex Laskey, are just not sexy. That's the problem. "Most people don't care that deeply about their energy usage," says the co-founder and president of Virginia-based Opower. What people do care about, he realised, is good customer service. And in 2007, when Opower was founded, the utilities industry had fallen way behind. "All the other major industries like finance and airlines had developed ways of giving their customers information to help them make better decisions," Laskey says. "Utilities need to become more customer centric, and they're also facing more regulatory pressure to pursue clean, efficient energy. We believed that if we worked with them to give consumers better information about their consumption, we could change the way people use energy."

So Laskey (*above left, with fellow co-founder Daniel Yates*), who had previously not been interested in starting a business, switched from trying to improve energy policy through working in politics to changing it from within the industry. Opower now provides energy management software for 100 providers on four continents, delivering data-driven customer reports enhanced with behavioural motivators such as comparing a customer's energy use to that of their neighbours. The result: ten terawatt-hours of electricity saved since 2007, with a reduction in carbon emissions equivalent to removing 1.5 million cars from the road.

In the early days, hope of such large-scale expansion wasn't what drove Laskey, who never anticipated Opower's growth. "Now, I'm bullish that we can grow ten times our size," he says. "But most companies aren't successful. Given that your chances aren't high anyway, you may as well do something where you're proud of what you're trying to accomplish." **KN** *opower.com*

Ceri Sheppard (*centre, left*), employment academy director at House of St Barnabas, and Sandra Schembri (*centre, right*), the organisation's CEO, in its Drawing Room. With them are participants of its training scheme that help homeless people to gain jobs in the hospitality sector



SOCIAL INTEGRATION

HOUSE OF ST BARNABAS

A members' club is training the homeless to gain employment

In 2006, the trustees of London charity the House of St Barnabas (HOSB) decided to rethink the use of a grade I listed Georgian building it owned in London's Soho and switched it from being a hostel for homeless women to a private members' club run as a hybrid of social enterprise and business. Partnering with café chain Benugo, they then devised employment preparation programmes in which homeless people would receive on-the-job training in hospitality services and continued mentoring to support them to regain a more independent life. Partner companies employ graduates from the scheme. Finding work is key to breaking the cycle of homelessness – HOSB's shift in approach tackles the problem itself, rather dealing with its effects. **RB** *hosb.org.uk*

PHOTOGRAPHY: JAY BROOKS

CLOTHING

PATAGONIA

A clothing brand is offering to make do and mend its customers' apparel



US-based outdoor-clothing company Patagonia uses materials that either benefit, or cause minimal damage to, the environment. Based in Ventura, California, it also pledges to give its manufacturing plants "safe, fair, legal and humane" working conditions. Having been steadily successful since it was founded in 1973, the company has doubled in size, tripled its profits and become a certified B Corp (see p97) over the past ten years. In 2009, Patagonia partnered with Walmart to set up the Sustainable Apparel Coalition, persuading companies such as Levi Strauss & Co, Nike, Gap and adidas to work with it as it drew up new standards for clothing manufacture.

The company's annual revenues, in excess of $600 million in 2013, have continued to rise, despite – or rather, partly due to – a programme called Worn Wear. This encourages consumers to conserve natural resources by sending worn-out garments to Patagonia for repair rather than buying new ones. The company claims sales have increased as a result. Patagonia, still privately owned by its founder, 77-year-old Yvon Chouinard, continues to donate at least one per cent of its annual net revenue to environmental causes, to date totalling $36 million.

CEO Rose Marcario (*left*), who joined in 2008, claims it's essential for a company like hers to examine what it can do, and take transparent action. "There is nothing we can change about making clothing that would have more positive environmental impact than making less," she says. "Worn Wear is a celebration of quality products and their relationship to our lives. It's simple: keep your gear in action longer and take some pressure off our planet." **RB** *patagonia.com*



EMPLOYMENT

TIMEWISE

Finding a suitable part-time job can be difficult, not least for parents re-entering the market, as Timewise founder Karen Mattison, 47, discovered when she was looking for a time-flexible position in 2012. So she launched her own job board, Timewise, for part-time or home-based work. "The glass ceiling for women is often about flexibility in the job market," Mattison says. Its London-based website has 70,000 registered users, 3,000 businesses that use the service and an average of 15,000 jobs. Mattison claims Timewise candidates fill 80 per cent of roles advertised. **PB** *timewise.co.uk*

ACTIVISM

CHANGE.ORG

Want to make a change? Create an online petition to gain support for your mission

Ben Rattray, founder and CEO of Santa Barbara-based petition site Change.org, decided to study law. This ambition lasted about as long as it took to get his first enrolment email. "That gave me access to what was then 'Thefacebook', and I realised the same technology that connected people around friends and photos could bring them together around causes that they cared about," Rattray, now 35, explains. It was easier said than done: Change.org went through multiple iterations until Ndumie Funda, 42, a South African LGBT activist, used the site to set up a petition against her government's history of ignoring corrective rape. More than 170,000 people signed it and the South African government set up a task force to tackle the issue. Rattray, who cites the flexibility of startup funding as an advantage over a non-profit structure where funding is tied to a set project, realised they'd hit on something big.

The site now charges startups and large non-profits to advertise companies such as Airbnb and Virgin America to users who've signed petitions. And although Change.org's war chest may pale in comparison to the large-scale tech companies that inspired it, Rattray claims this is no impediment to recruiting highly skilled workers. "The marketplace is incredibly competitive," he says. "But merely having money is insufficient to attract the top talent – they'll have plenty of similar offers. Increasingly, people are looking to work at organisations that have a social mission they can dedicate themselves to." **KN** *change.org*



INSURANCE



MICROENSURE

British-based company MicroEnsure sells insurance in African and Asian markets where average incomes are less than $15 a day, only two per cent of people have ever been insured, and risks to livelihood are high. Not exactly an easy-money gig, you might think, yet the company has 15 million policyholders in 16 countries and it claims to attract one million customers per month.

The startup puts its success down to well-targeted products and innovative marketing. CEO Richard Leftley (*left*) realised years ago that big insurers were leaving a market unserviced: home and life insurance are popular in the west, but African and Asian consumers were more interested in protection in case of crop failure or political violence. Those who attempted to insure themselves faced off-putting questions.

Leftley, 42, pioneered better-targeted policies and simplified the signing-up process. "Insurance companies love data," he says. "But the fact is, much of what they gather isn't used. We just collect what's relevant." The breakthrough came in 2006 when he began working with wireless phone networks Airtel (in Africa) and Telenor (in Asia). MicroEnsure creates basic healthcare packages that the networks bought, branded and gave away free with airtime. Once customers had those packages, the networks upsold insurance for family members, and more network-branded, paid-for policies. Subscriptions and claims are paid via SMS.

MicroEnsure also sells its own policies and creates giveaway policies for banks, but phone networks are most effective for distribution. "The networks tend to be one of the few things that always work, so they have a fantastic brand presence," Leftley says. "People believe in them."

Leftley believes that, having experienced being insured, low-income Africans and Asians will see it as essential. Benefits to local economies should follow, as insurance reduces poverty and enables greater risk-taking. He also predicts an impact on the way insurance is sold in the west. "This will affect how insurance is marketed to the young and the self-employed [in the UK]. Policies will follow the *Angry Birds* model: free but with paid-for bolt-ons. And making claims will be as easy as voting on *The X Factor*." **RB**
microensure.com

CONSUMER GOODS

UNILEVER

The consumer-goods company explains its sustainable mission to achieve B Corp status



Just how big can a B Corp be? The question became a talking point in socially conscious business circles at the end of 2014 when Natura, Brazil's leading toiletries and cosmetics company, was officially certified. Unlike most of the 1,400 B Corps, Natura is international and publicly owned, with 7,000 employees and annual sales of around $2.65 billion. Two months later, Unilever chief executive Paul Polman told a *Guardian* reporter at the World Economic Forum in Davos that the multinational company was looking into becoming a B Corp itself. The difficulties presented by operating in multiple territories would make this complex, but the fact that Polman had even considered it showed how far the debate had progressed.

Since 2010, Unilever has been following a corporate strategy known as its Sustainable Living Plan, which has the ambition of limiting its environmental footprint. This has meant a commitment to sourcing cleaner energy and eliminating waste and unsustainable ingredients such as palm oil. Unilever's scale – it operates in more than 190 countries, reaching two billion consumers per day, with nearly 60 per cent of its business in developing markets – means it has the potential to make a significant impact. For example, the environmental effect of all its consumers switching to its concentrated products would be the equivalent of removing the emissions of one million combustion-engine-powered vehicles.

"Our Sustainable Living brands are growing twice as fast as others in our portfolio and deliver more than half of our growth," says Keith Weed (*left*), Unilever's chief marketing and communications officer. "When people ask me, 'What is the business case for sustainability?' I always ask them, 'What's the case for the alternative?'"

Beyond this, the company has made wide-ranging social interventions, such as adopting the Dirt is Good campaign for Persil and associated brands, to foster healthy child development. And Unilever scientists are innovating to meet local energy conditions – building pedal-powered washing machines in developing markets, for instance.

Key to this strategy are Unilever's brands, of which there are more than 400, although not all are in the Sustainable Living portfolio. "Consumers are aware of the challenges in the world and are more interested in brands that have a purpose beyond functional benefits – they want an idea to buy into, not just want a product to buy," Weed says. "By using household brands to carry the message that we can all create a bright future through our actions, people are inspired to help create change and contribute in whatever way possible." **RB** *unilever.co.uk*

PHOTOGRAPHY: WILSON HENNESSY

CHILD HEALTH

EMBRACE

How an Indian startup launched a 'buy a blanket, save a life' enterprise for customers in the US



Bengaluru-based Embrace Innovations nearly went bust in 2014. The social enterprise had begun the year with contracts to supply its frugal incubator warmers for premature babies (*above*) to ten Indian state governments. Then the election rolled around and government budgets were put on hold. "It was like going back to square one," explains CEO Jane Chen. That also affected Embrace, the non-profit that Chen co-founded in 2008, which distributes the incubators for free and owns the intellectual property, receiving a proportion of every sale Embrace Innovations makes. So Chen, 37, decided to expand into commercial sales.

"We launched a range of blankets in the US called Little Lotus, which uses similar technology as our incubators," she explains. "Every blanket we sell helps save a baby in a developing country with our incubator." A Kickstarter campaign last May raised $130,398 and blankets began shipping in December. "The loyalty of our customers is incredible because they love the social mission," Chen says.

Embrace has already reached 200,000 babies in the developing world and Chen sees a profitable business as essential in reaching its goal of one billion units. "The Little Lotus model is the programme to get us there," she says. "I really believe that profitability and scalability go hand in hand." **KN** *embraceinnovations.com*

PROPERTY RIGHTS

SUYO

Suyo – Spanish for "yours" – is a year-old startup based in Medellín, Colombia, that enables the country's low-income householders to register their property rights so that they are fully recognised by law. In many cases, the necessary home documentation is non-existent, meaning householders can lose access to social services or be evicted by another party making a claim on the land. The process, which involves lawyers and negotiating complex government bureaucracy, can cost up to $2,500. Suyo, however, charges as little as $1,440.

Suyo co-founder Matt Alexander (*below*) explains that costs are saved by using technology such as a tailored mobile app for capturing and submitting property measurements – Colombia's government can't afford to send employees to register all the country's unrecorded dwellings. As many homeowners lack the funds or confidence to take their case to the government, Alexander, 38, says that there's scope for private enterprise to "facilitate access". **RB** *suyo.co*



RECYCLING

CLOSED LOOP

Waste can be upcycled – with the help of a story

Closed Loop, the world's largest food- and hospitality-industry recycling company, uses marketing to tap into consumer tastes. The Australian company managed food recycling at the 2000 Sydney Olympics: its owners realised there was a huge market for recycled goods – if they were branded well.

Closed Loop brokered deals with brands that guaranteed a supply of "post-consumer" materials, which its partners used to create new products. The demand resulted in a market for post-waste materials and the increase in revenues meant that Closed Loop could invest in more efficient collection methods. Much of the company's energy is now focused on Simply Cups, an initiative to rescue the 2.5 billion polyethylene-coated paper cups that end up in landfill each year.

"There is value in sustainability because it affects buying decisions," says Closed Loop director Peter Goodwin. "But you have to have a credible story – then you can drive behavioural change."

If you want to change a situation, "you have to make sure every stakeholder benefits. Now, there are eight stakeholders in a paper cup: manufacturer; distributor; caterer; end user; cleaner; waste collector; post-consumer material salesperson; and reprocessor. Every one makes commercial decisions based on their own interest, so you have to create a system that benefits all." **RB** *closedloop.com.au; simplycups.co.uk*



RETAIL

WARBY PARKER

Every time this US-based eyewear brand sells a pair of glasses, it benefits people in developing countries

Starting from day one, we wanted to build a company that made us excited to go to work," says Neil Blumenthal (*near right*). "And we knew that feeling would relate to the impact that our organisation could have on the world."

Blumenthal, the co-founder and co-CEO of New York eyewear retailer Warby Parker, is explaining how, for his company, business and social benefit are indivisible aspects of the same mission. Warby Parker was founded in 2010 by four entrepreneurs – Blumenthal, 35, Dave Gilboa (*far right*), 35, Andy Hunt, 34, and Jeff Raider, 35 – who sought to sell stylish spectacles at affordable prices ($95). The team achieved this by selling online and designing and manufacturing the products themselves, which eliminates expensive brand licensing costs.

It extended the mission with an arrangement whereby each month the company donates an amount equal to the wholesale value of the spectacles sold. The money is given to non-profit partners – chiefly VisionSpring – which train people in developing countries to give eye examinations and sell glasses.

The point is to create a functioning market, with expensive frames effectively subsiding cheaper designs. In developing countries, obtaining and wearing spectacles increases the income of the sight-impaired by an average of 20 per cent. This created wealth sustains the market and optical-care provision, so eyewear can be repaired and updated – something that tends not to happen when glasses are just handed out by charities.

The rationale isn't just emotional, says Blumenthal. "There's a business rationale, too: the prospect of doing good is a powerful motivating force for us and the people we hoped to hire. There's an often-cited 2014 Pew study ['Millennials in Adulthood'] that found that millennials prioritise helping people in need over raking in a huge pay cheque. We knew that if we were going to entice passionate young people to join our team, we needed to offer what they valued most."

It seems to be working so far. Warby Parker now has 37 physical stores across the US as well as its online business, and has been valued at $1.2bn – which would make it the second most valuable private, venture-backed e-commerce company in the world. **RB** *warbyparker.com*

"The prospect of doing good is a powerful motivating force," says Neil Blumenthal (*left*), with Dave Gilboa, his co-CEO and co-founder of eyewear retailer Warby Parker



PHOTOGRAPHY: CHRIS CRISMAN

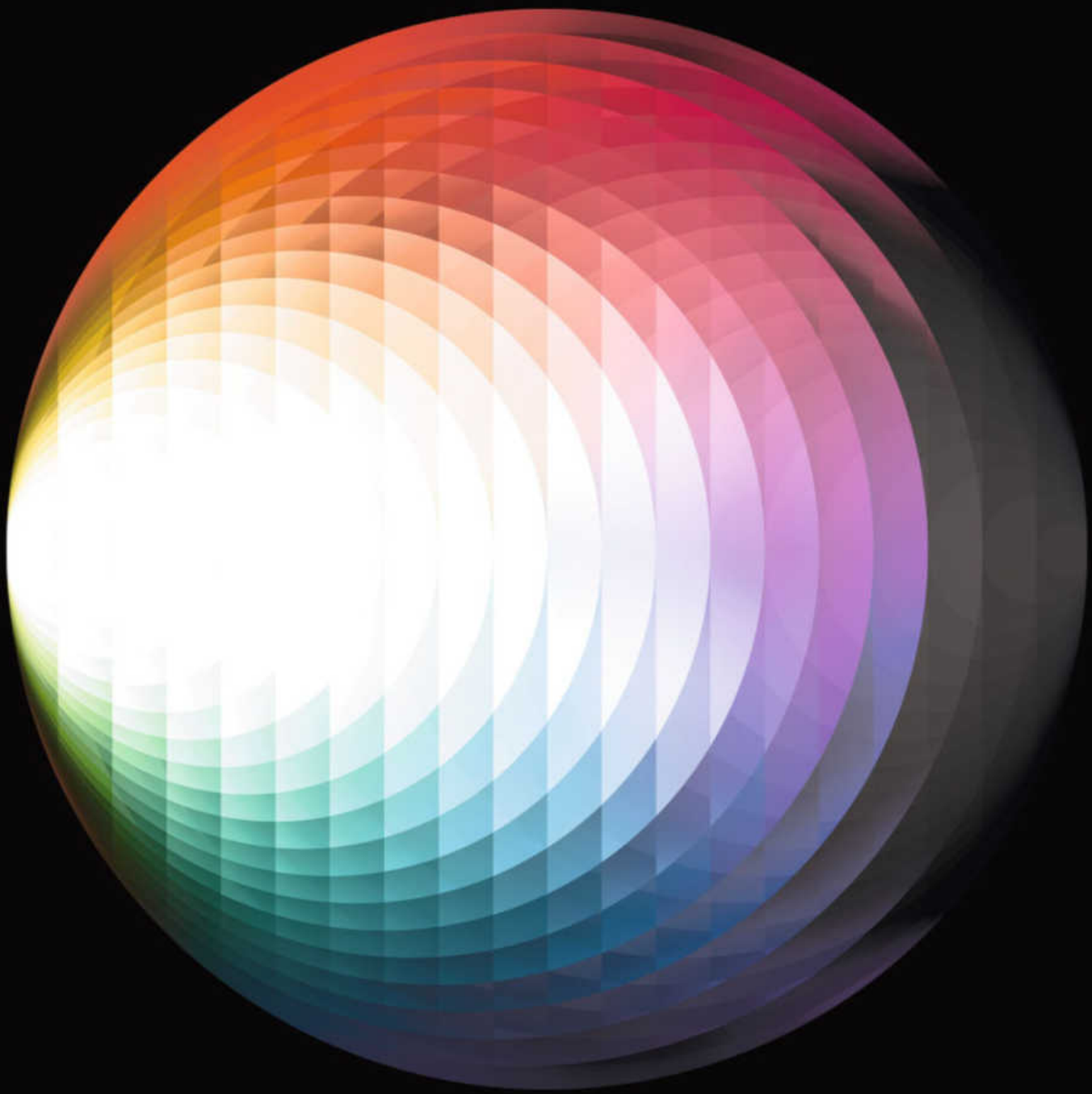
HYPERVISION

The world's hottest startup isn't located in Silicon Valley – it's in suburban Florida.

KEVIN KELLY explores what Magic Leap's mind-bending technology tells us about the future of VR

Photography:
PETER YANG

Illustration:
ANDY GILMORE



here is something special happening in a generic office park in an uninspiring suburb near Fort Lauderdale, Florida. Inside, amid the low grey cubicles, clustered desks and empty swivel chairs, an impossible 20cm robot drone from an alien planet hovers chest-high in front of a row of potted plants. It is steampunk-cute, minutely detailed. I can walk around it and examine it from any angle. I can squat to look at its ornate underside. Bending closer, I bring my face right up close to inspect its tiny pipes and protruding armatures. I can see polishing swirls where the metallic surface was "milled". When I raise a hand, it approaches and extends a glowing appendage to touch my fingertip. I reach out and move it around. I step back across the room to view it from afar. All the while it hums and slowly rotates above a desk. It looks as real as the lamps and computer monitors around it. It's not. I'm seeing all this through a synthetic-reality headset. Intellectually, I know this drone is an elaborate simulation, but as far as my eyes are concerned it's really there, in that ordinary office. It is a virtual object, but there is no evidence of pixels or digital artifacts in its three-dimensional fullness. If I reposition my head just so, I can get the virtual drone to line up in front of a bright office lamp and perceive that it is faintly transparent, but that hint does not impede the strong sense of it being present. This, of course, is one of the great promises of artificial reality – either you get teleported to magical places or magical things get teleported to you. And in this prototype headset, created by the much-speculated-about, ultra-secretive company called Magic Leap, this alien drone certainly does seem to be transported to this office in Florida – and its reality is stronger than I thought possible.

I saw other things with these magical goggles. I saw human-sized robots walk through the actual walls of the room. I could shoot them with power blasts from a prop gun I really held in my hands. I watched miniature humans wrestle each other on a real tabletop, almost like a *Star Wars* holographic chess game. These tiny people were obviously not real, despite their photographic realism, but they were really present – in a way that didn't seem to reside in my eyes alone; I almost felt their presence.

Virtual reality overlaid on the real world in this manner is called mixed reality (MR). The goggles are semi-transparent, allowing you to see your actual surroundings. It is more difficult to achieve than the classic fully immersive virtual reality (VR), where all you see are synthetic images, and in many ways MR is the more powerful of the two technologies.

Magic Leap is not the only company creating mixed-reality technology, but right now the quality of its virtual visions exceeds all others. Because of this lead, money is pouring into this Florida office park. Google was one of the first to invest. Andreessen Horowitz, Kleiner Perkins and others followed. In the past year, executives from most major media and tech companies have made the pilgrimage to Magic Leap's office park to experience for themselves its futuristic synthetic reality. At the beginning of this year, the company completed what may be the largest C-round of financing in history: $793 million (£556m). To date, investors have funnelled $1.4 billion into it.

That astounding sum is especially noteworthy because Magic Leap has not released a beta version of its product, not even to developers. Aside from potential investors and advisers, few people have been allowed to see the gear in action, and the combination of funding and mystery has fuelled rampant curiosity. But to really understand what's happening at Magic Leap, you need to also understand the tidal wave surging through the entire tech industry. All the major players – Facebook, Google, Apple, Amazon, Microsoft, Sony, Samsung – have whole groups dedicated to artificial reality, and they're hiring more engineers daily. Facebook alone has more than 400 people working on VR. Then there are some 230 other companies, such as Meta, the Void, Atheer, Lytro and 8i, working furiously on hardware and content for this new platform. To fully appreciate Magic Leap's gravitational pull, you must see this emerging industry – every virtual-reality and mixed-reality headset, every VR camera technique, all the novel VR applications, beta-version VR games, every prototype VR social world. As I did – over the past five months.

Then you will understand just how fundamental VR technology will be, and why businesses such as Magic Leap have an opportunity to become some of the largest companies ever created.



Rony Abovitz displaying Magic Leap's mysterious photonic light-field chip in March this year

Even if you've never tried virtual reality, you probably possess a vivid expectation of what it will be like. It's *The Matrix*, a reality of such convincing verisimilitude that you can't tell if it's fake. It will be the Metaverse in Neal Stephenson's rollicking 1992 novel, *Snow Crash*, an urban reality so enticing that some people never leave it. It will be the Oasis in the 2011 best-selling story *Ready Player One*, a vast planet-scale virtual reality that is the centre of school and work. VR has been so fully imagined for so long, in fact, that it seems overdue.

I first put my head into virtual reality in 1989. Before even the web existed, I visited an office in Northern California whose walls were covered with neoprene surfing suits embroidered with wires, large gloves festooned with electronic components and rows of modified swimming goggles. My host, Jaron Lanier, sporting shoulder-length blond dreadlocks, handed me a black glove and placed a set of home-made goggles secured by a web of straps on to my head. The next moment I was in an entirely different place. It was an airy, cartoony block world, not unlike the *Minecraft* universe. There was another avatar sharing this small world (the size of a large room) with me – Lanier.

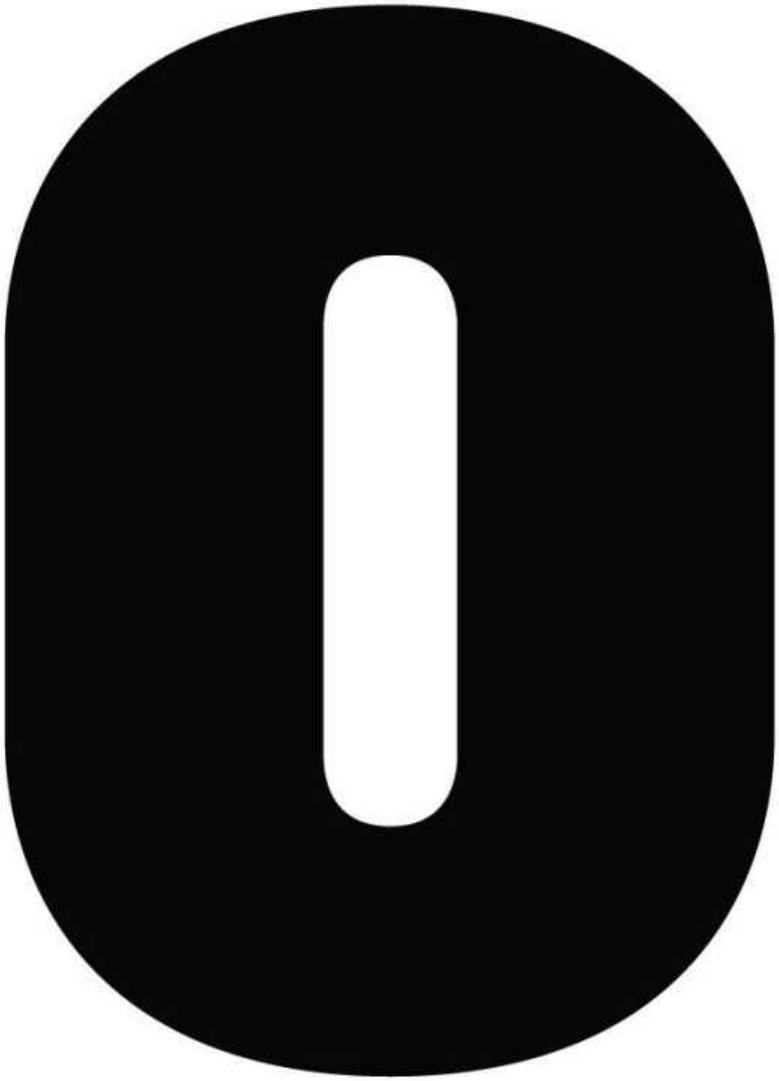
We explored this magical artificial landscape together, which Lanier had created just hours before. Our gloved hands could pick up and move virtual objects. It was Lanier who named this new experience "virtual reality". It felt unbelievably real. In that short visit I knew I had seen the future. The following year I organised the first public hands-on exhibit (called Cyberthon), which premiered two dozen experimental VR systems from the US military, universities and Silicon Valley. For 24 hours in 1990, anyone who bought a ticket could try virtual reality. The quality of the VR experience at that time was primitive but still pretty good. All the key elements were there: head-mounted display, glove tracking, multi-person social immersion.

But the arrival of mass-market VR wasn't imminent. The gear cost many scores of thousands of dollars. Over the following decades, inventors were able to improve the quality, but they were unable to lower the cost.

Twenty-five years later a most unlikely savior emerged – the smartphone! Its runaway global success drove the quality of tiny hi-res screens way up and their cost way down. Gyroscopes and motion sensors embedded in phones could be borrowed by VR displays to track head, hand and body positions for pennies. And the processing power of a modern phone's chip was equal to an old supercomputer, streaming movies on the tiny screen with ease. The cheap ubiquity of screens and chips allowed

a teenage Palmer Luckey to gaffer-tape together his first VR headset prototypes, launching a Kickstarter campaign for the Oculus Rift in 2012. And the Rift was the starting signal that many entrepreneurs were waiting for. (Facebook bought the company for $2 billion in 2014.)

All of today's head-mounted VR displays are built out of this cheap phone technology. Lanier, who has contributed to Microsoft's HoloLens MR system, estimates it would have cost more than $1 million in 1990 to achieve the results that even simple phone-inserted headsets like the Samsung Gear or Google Cardboard do today.



ne of the first things I learned from my recent tour of the synthetic-reality waterfront is that virtual reality is creating the next internet. Today the internet is a network of information. It contains 60 trillion web pages, remembers four zettabytes of data, transmits millions of emails per second, all interconnected by sextillions of transistors. Our lives and work run on this internet of information. But what we are building with artificial reality is an internet of experiences. What you share in VR or MR gear is an experience. What you encounter when you open a magic window in your living room is an experience. What you join in a mixed-reality teleconference is an experience. To a remarkable degree, all these technologically enabled experiences will rapidly intersect and inform one another.

The recurring discovery I made in each virtual world I entered was that although every one of these environments was fake, the experiences I had in them were genuine. VR does two important things: one, it generates an intense and convincing sense of what is generally called presence. Virtual landscapes, virtual objects and virtual characters seem to be there – a perception that is not so much a visual illusion as a gut feeling. That's magical. But the second thing it does is more important. The technology forces you to be present – in a way flatscreens do not – so that you gain authentic experiences, as authentic as in real life. People remember VR experiences not as a memory of something they saw but as something that happened to them.

Experience is the new currency in VR and MR. Technologies such as Magic Leap's will enable us to generate, transmit, quantify, refine, personalise, magnify, discover, share, reshare and overshare experiences. This shift from the creation, transmission, and consumption of information to the creation, transmission and consumption of experience defines this new platform. As Magic Leap founder Rony Abovitz puts it: "Ours is a journey of inner space. We are building the internet of presence and experience."

We haven't yet fully absorbed the enormous benefit that the internet of information has brought to the world. And yet we are about to recapitulate this accomplishment with the advent of synthetic realities. With a VR platform we will create a Wikipedia of experiences, potentially available to anyone, anywhere, anytime. Travel experiences – terror at the edge of an erupting volcano, wonder at a walking tour of the pyramids – once the luxury of the rich (like books in the old days) will be accessible to anyone with a VR rig. Or experiences to be shared: marching with protesters in Iran; dancing with revellers in Malawi; how about switching genders? Experiences that no humans have had: exploring Mars; living as a lobster; experiencing a close-up of your own beating heart, live.

You've seen a lot of this in movies and on TV or read about it in books. But you haven't experienced it, felt it below your intellect, had it lodge in your being in a way that you can call your own. Kent Bye, founder of the podcast *Voices of VR*, has conducted more than 400 interviews with the people creating VR and has seen almost every possible prototype of VR there is. "VR talks to our subconscious mind like no other media," he says.

The most complete sense of subconscious presence that I experienced occurred with a system called the Void, which debuted at the 2016 TED conference in Vancouver. The Void isn't as advanced as Magic Leap technologically, but it integrates the best off-the-shelf parts available with



custom gear to create an unforgettable experience. For several hours I watched a line of people enter the Void. Almost every person squealed with delight and staggered away asking for more.

The Void grew out of stage magic, a theme park and a haunted house. Every year, Ken Bretschneider, one of the three co-founders, stages a gonzo haunted house in Utah that draws 10,000 people in two days. It occurred to him that he could amplify the interactions of his house with VR. Curtis Hickman, the second co-founder, is a professional illusionist and a visual-effects producer. The third, James Jensen, started out developing special effects for film and unique experiences for theme parks. He came up with the idea of layering VR over a physical playground. The common factor among the three was their realisation that VR was a new way to trick the mind.

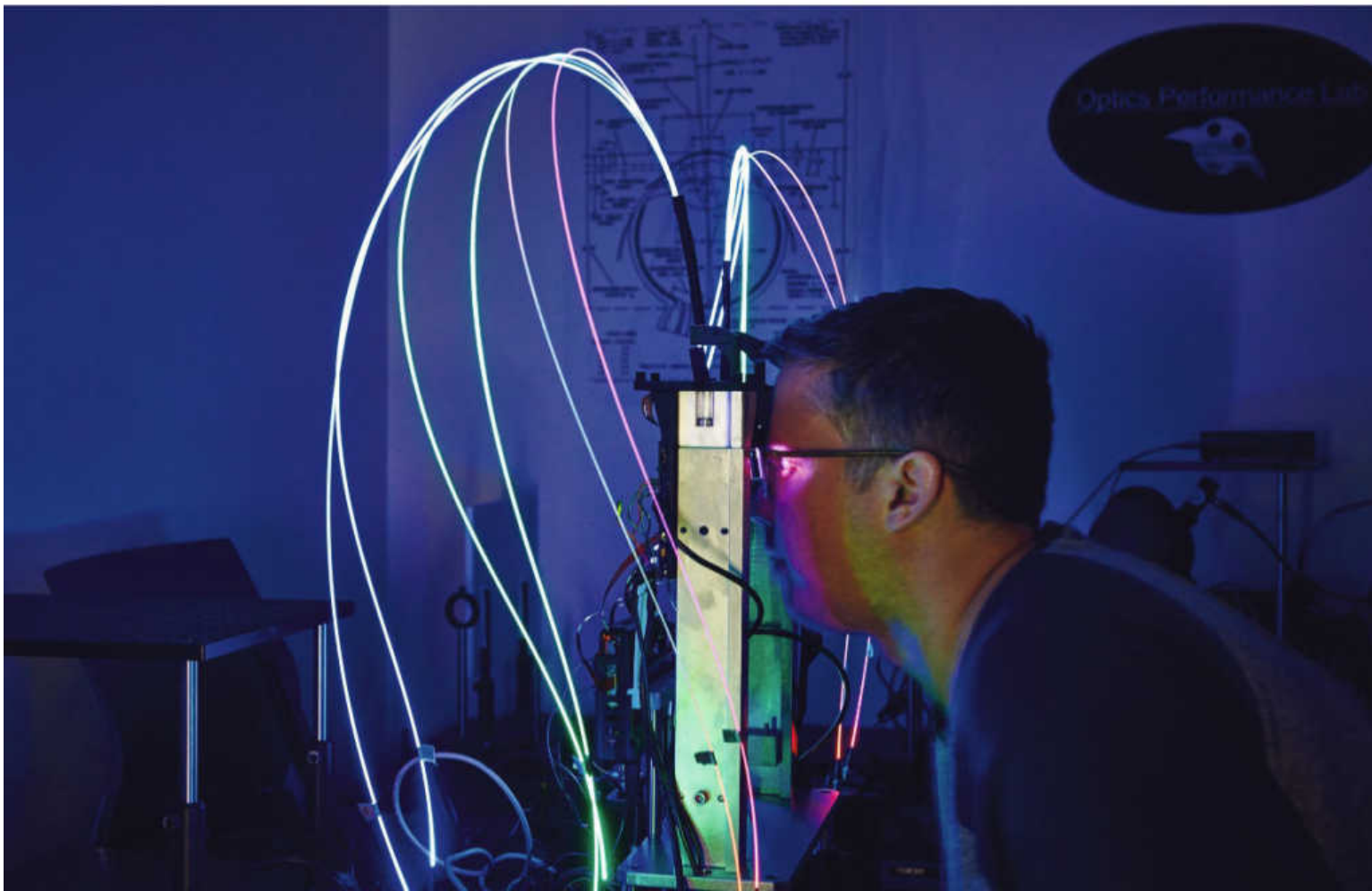
The Void takes place in a large room. You wear a 5kg vest that carries batteries, a processor board, and 22 haptic patches that vibrate and shake you at the right moments. Your headset and earphones are connected to your vest, so you're free to roam without a cord or tripping over a cable. That relief heightens the effect of being present in the VR. Inside, you navigate an Indiana Jones-like adventure that seems to take place over a large territory. The illusion of unbounded space, or, as Hickman describes it, "a magical space bigger inside than it is outside", is achieved by a trick called redirected walking.

As an example, whenever you turn 90 degrees your VR will show you the room turning only 80 degrees. You don't notice the difference, but the VR accumulates those small ten-degree cheats until it redirects your route or even gets you to walk in a circle while making you think you've walked a kilometre in a straight line. Redirected touching does a similar trick. A room could contain one real block but display three virtual blocks on a shelf. You see your hand grab a block, but the VR system will direct your hand to touch the only real block.

It's astounding how those tiny misdirections fool you into believing that what you're seeing is real. Stairs can be made to feel endless if they drop down as you walk upward. In fact, at one point in the Void a decaying floor collapses while you're walking across it, and you see, hear, and feel a plunge down to the floor below. But in fact the real floor only sinks 15cm.

Seeing, it turns out, is not believing. We use all our senses to gauge reality. Most of the high-end VR rigs on sale this year include dynamic binaural – that is, 3D – audio. This is more than just stereo, which is fixed in space. To be persuasive, the apparent location of a sound needs to shift as you move your head. Deep presence includes the sensations of motion from your inner ear; if the two are out of sync with what you see, you get motion sickness.

Good VR also includes touch. Jason Jerald, a professor at the Waterford Institute of Technology in Ireland, claims that much of our sense of presence in VR comes from our hands. Gloves are still not consumer-ready, so hardware makers are using controllers with a few easily operated buttons. When you wave them, their positions are tracked, so you can manipulate virtual objects. As primitive as these stick-hands are, they double the sense of being present. Touch, vision and sound form the essential trinity of VR.



Engineer Eric Browy working in the Magic Leap optics lab

Although Magic Leap has yet to achieve the immersion of the Void, it is still, by far, the most impressive on the visual front – the best at creating the illusion that virtual objects truly exist. The founder of Magic Leap, Rony Abovitz, is the perfect misfit to invent this superpower. As a kid growing up in south Florida, he was enthralled by science fiction and robots. Abovitz gravitated towards robots as a career and got a degree in biomedical engineering from the University of Miami. While he was a student, he started a company that built robots for surgery.

Abovitz is heavy-set, bespectacled and usually smiling. He hums with ideas. Overflowing. One idea unleashes two more. Most of his ideas seem to combine physics and biology. In his Twitter bio, Abovitz describes himself as a "friend of people, animals, and robots", which is pretty accurate. In his conversation and his work he exhibits a rare sensitivity to both the logic of machines and the soul of biology. If you're making robot arms that help human doctors carve into living flesh, you have to obey the laws of physics, the laws of biology and the minds of humans. Abovitz has a knack for all three realms, and his surgery robots sold well. In 2008, his company, Mako, went public. It was sold in 2013 for $1.65 billion.

That success sparked a new idea. Could you make a virtual knee to help repair a real knee? Could you augment a knee operation with an overlay of a virtual knee? Abovitz began thinking about the technology that could match virtual worlds with complex real-life surgery. At the same time he began to create a graphic novel.

Abovitz has a deep love of science fiction, and he invented a whole world on another planet – flying whales, men in dragonfly gear, a young girl with a pet monkey-bat and an invading army of robots. Flush with cash from his robotics company, he hired Weta Workshop, the New Zealand special-effects house co-owned by movie director Peter Jackson, to create a detailed realisation of that world. For Abovitz they designed his world, called Hour Blue, and it quickly mutated from graphic novel into virtual-reality precursor. Because what alien world would not be better experienced in immersive 3D? Abovitz was already pioneering MR for doctors; this would be an extension of his ideas.

The company Abovitz set up to develop this immersive world was Magic Leap. Its logo would be his totem animal, the leaping whale. The hardware to create the MR would have to be invented. By this time, 2012, the Oculus Kickstarter campaign had launched and other prototypes with similar phone-based technology were in the works. Here Abovitz deviated off the path. Because of his work in biomedicine, he realised that VR is the most advanced technology in the world where humans are still an integral part of the hardware. To function, VR and MR must use biological circuits as well as silicon chips. The sense of presence you feel in these headsets is created not by the screen but by your neurology. "If you give the mind and body what they want, they'll give you back much more," Abovitz says.

Artificial reality exploits peculiarities in our senses. It effectively hacks the human brain to create what can be called a chain of persuasion. In a movie, our brains perceive real motion in a sequence of still images. In the same way, you can scan a blue whale from many angles and then render it as a 3D volumetric image that can be displayed on a headset screen and viewed from any position. Even if we know the object isn't real, we feel subconsciously that its presence is real.

But if even one small thing is misaligned, that discrepancy can break the illusion of presence. Something as simple as worrying about tripping over a cable can seed our unconsciousness with doubt. It might look like it's there, but it won't *feel* there.

Following his hunch to exploit human biology, Abovitz set off to make an artificial-reality display in a more symbiont way. The phonelike screens used in the majority of head-mounted displays created a problem: they were placed right next to your eyeballs. If the device is generating the illusion of a whale 30 metres away, your eyes should be focused 30 metres away. But they're not; they're focused on the tiny screen 2cm away. Likewise, when you look at a virtual jellyfish floating 15cm from your face, your eyes are not crossed as they would be in real life but staring ahead. No one is conscious of this optical mismatch, but over long use it could weaken the chain of persuasion. Magic Leap's solution is an optical system that creates the illusion of depth so that your eyes focus far for far things and near for near, and will converge or diverge at the correct distances.

In trying out Magic Leap's prototype, I found that it worked amazingly well close up, which was not true of many of the other mixed- and virtual-reality systems I used. I also found that the transition back to the real world while removing the Magic Leap's optics was effortless, as comfortable as slipping off sunglasses, which I also did not experience in other systems.

Magic Leap's competition is formidable. Microsoft is selling development versions of its MR visor called the HoloLens. The technology is unique in that the entire contraption – processor, optics and battery – is contained in the visor; it is truly untethered. Meta, another startup, has released an MR device that began, like Oculus, with a Kickstarter campaign. The headset is

REAL WORLDS

What's the reality? **BLANCA MYERS** explains the differences



Virtual reality
VR places the user in another location entirely. Whether that location has been generated by a computer or captured by video, it entirely occludes the user's natural surroundings.



Augmented reality
In augmented reality – like Google Glass or the *Yelp* app's Monocle feature on mobile devices – the visible natural world is overlaid with a layer of digital content.



Mixed reality
In technologies such as Magic Leap's, virtual objects are integrated into the natural world. A virtual ball under your desk, for example, would be blocked from view unless you bent down to look at it.



Magic Leap's user experience team creates guides to new universes

will soon abandon desktop screens in favour of virtual displays. Meron Gribetz, founder of Meta, says that its new Meta 2 mixed-reality glasses will replace monitors in his company within a year. It's no great leap to imagine such glasses also replacing the small screens we all keep in our pockets. In other words, this is a technology that can simultaneously upend desktop PCs, laptops and phones. No wonder Apple, Samsung and everyone else is paying attention. This is what disruptionon a vast scale looks like.

tethered to a computer and dev kits should hit the market this autumn – likely well before Magic Leap.

All three major MR headsets rely on images that are projected edgeways on to a semi-transparent material – usually glass with a coating of nanoscale ridges. The user sees the outside world through the glass, while the virtual elements are projected from a light source at the edge of the glass and then reflected into the user's eyes by the beam-splitting nano-ridges. Magic Leap claims that its device is unique in the way it beams light, though the company declines to explain it further for now.

However Magic Leap works, its advantage is that pixels disappear. Most screen-based, head-mounted VR displays exhibit a faint "screen door" effect that comes from a visible grid of pixels. Magic Leap's virtual images, by contrast, are smooth and incredibly realistic. But in truth, the quality of displays in all alternative-reality gear is improving rapidly. Within two decades, when you look into a virtual-reality display, your eye will be fooled into thinking you're looking through a real window into a real world.

Once this small display perfects realism, it becomes the one display to rule them all. If a near-eye screen offers sufficient resolution, brightness, breadth and colour richness, it can display any number of virtual screens, of any size, inside it. While I was wearing the photonic spectacles of Magic Leap, I watched an HD movie on a virtual movie screen. It looked as bright and crisp as my TV at home. With Microsoft's HoloLens on, I watched a live football game on a virtual screen, alongside a few other virtual screens. I could fill my office with as many screens as I wanted. I could click for a screen overlaid anywhere in the real world.

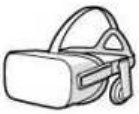
One of Microsoft's ambitions for the HoloLens is to replace all the various screens in a typical office with wearable devices. The company's demos envision workers moving virtual screens around or clicking to be teleported to a 3D conference room with a dozen co-workers who live in different cities. At Magic Leap, the development team

Peter Jackson agrees. The director strides into a sunny room in his film studio outside Wellington, New Zealand. Jackson says he is less than excited about making movies these days; not the content but the process. He sees artificial reality as virgin territory for telling stories and creating new worlds. Jackson serves on an advisory panel for Magic Leap, and his company will produce content for the new gear. "This mixed reality is not an extension of 3D movies. It's different," he says. "Once you can create the illusion of objects anywhere you want, you create new entertainment opportunities."

Jackson has been inspired by working with prototypes of the Magic Leap glasses. "I find mixed reality much more exciting than VR," he says. "MR doesn't take you out of this world. Instead, it adds elements to our real world. And it has great flexibility. You can add as little as you want – a tiny figure on this table talking to us – or you can replace the walls of this room with a skyscape so we're sitting watching clouds float by. With Magic Leap glasses on, you can

A GAGGLE OF GOGGLES

As virtual (and mixed) technology improves, everyone is getting involved. Here's the hardware that VR's and MR's biggest players are cooking up. CHELSEA LEU



Facebook
In 2014, Facebook bought Oculus, the company that dreamed up the Rift headset and kick-started the VR revolution.

▶ Now



HTC
The Taiwanese phone producer teamed up with game-maker Valve Software to launch a high-end headset, the HTC Vive.

▶ Now



Sony
Sony's PlayStation VR is designed to work not with a PC but its own game console – which more than 36 million own.

▶ October 16



Google
Google created Cardboard, its assemble-it-yourself viewer, to bring virtual reality to the masses via their smartphones.

▶ Now



Samsung
The Gear VR straps a Galaxy smartphone to your head to deliver games and apps – all powered by Oculus software.

▶ Now



OSVR
An open-source platform for VR and MR launched in 2015, backed by a consortium of companies like Intel and Razer.

▶ Dev kit

look up at the Empire State Building and watch it being built in the early 1930s but sped up. It could be a form of education, entertainment and tourism. In ten years, I expect that MR technology like Magic Leap will be used as much as, if not more than, smartphones."

Weta Workshop's skill is in making imaginary worlds believable by attending to the details. Blockbuster MR and VR worlds will require the highest level of building. The freedom of the audience to move around, to peek at the underside of things, to linger and appreciate the details, means that great effort and skill will be needed to preserve the chain of persuasion for all the things that make up that world.

Weta is working with Magic Leap to develop a virtual world called Dr Grordbort's, based on sculpted ray guns. Leading this effort is Richard Taylor, who has been building worlds, often with Jackson, for nearly 30 years. Taylor has been a sculptor all his life and the move to virtuality is a big step for him. "I was not prepared for the emotional impact of Magic Leap," he says. "I could not have thought I would crave to be in a world with virtual artefacts and characters. But once I got over the surprise that this really works, I've had to rein in my ideas."

Artificial reality will need world builders like Taylor and Jackson to invent the grammar of VR and MR. It's already clear that the language of experiences is different from what's come before. One example: first-person point of view is the default for many of the video-game franchises dominating bestseller lists. Among them is *Minecraft*, which is played by more than 100 million people on the screens of PCs, tablets and phones. Inside the game you see your hand or a pick. But in the VR version of *Minecraft* that



Two robots, Click and Clack, test and calibrate prototype hardware

VR HACKS THE BRAIN

Microsoft is building, the experience of holding the pick and chopping the blocks is so immediate that the player's own presence is amplified. Their sense of being shifts inward. In tests with volunteers, *Minecraft* developers discovered that performing the same role in VR feels more intimate than it does in first-person on a flatscreen. We might call this new immersive VR view the "you-person", because it's the position of feeling rather than observing.

Researchers found that the you-person view that VR creates is so intense that it's emotionally taxing. The degree of presence can be so strong in VR that you have to tone down the evocation of base emotions and the depiction of brute force. The usual gore and mayhem of a first-person shooter doesn't work as well in VR. Exaggerated scenarios that are merely compelling in a flat world can be overwhelming when you're immersed in them.

All that said, it was not the reality of artificial reality that surprised me most. It was how social it is. The best experiences I had in VR or MR involved at least one other person. More people made it better. It's a network effect: the joy of VR is proportional to the square of the number of people sharing it. That means VR will be the most social medium yet. More social than social media is today.

One of my first tests for the quality of virtual reality was something I call the bat-flinch test. If you stood next to someone who was holding a virtual baseball bat and they swung the bat, would you duck? Only if you believed in it. Otherwise you'd just laugh or maybe wait to see what getting hit "felt" like. You'd never wait to get hit in real life.

But a better test is the poker-game test. Do the avatars sitting across from you convey sufficient subtle eye contact, body language and social presence that you can tell if they're bluffing?

I visited an Oculus demo at Facebook's campus and Palmer Luckey, Oculus' creator, joined in. We shared a virtual playground. In real life, Luckey is exuberant. He likes to bounce. He

▶ Availability VR MR



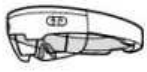
Apple
The Cupertino-based tech giant has patented an iPhone-compatible headset – but hasn't announced anything yet.

▶ N/A N/A



Fove
This startup proposes to use eye tracking to sharpen what you focus on and blur the rest, cutting down on power.

▶ Autumn 2016



Microsoft
HoloLens is a wireless, wearable, sensor-packed computer that aggregates its data to embed holograms in the user's space.

▶ Dev kit



Meta
Funded in 2013 via Kickstarter, the startup has created a visor that projects virtual interactive displays in the wearer's vision.

▶ Now

pumps his arms, not just his hands, as he speaks. That body language crossed over into VR. Even though our avatars did not map our outside visual features, Luckey's avatar moved just like him. He was playfully throwing blocks at me. They passed the bat-flinch test because I was ducking. Luckey was an expert in lighting virtual firecrackers and fireworks and tossing them my way too. Their explosions were real enough that I needed to back away. His enthusiasm was contagious, so I tried to blow him up with a blaster, but I missed and knocked down a tower. Although the physics of this demo, called Toybox, were remarkable, the toys felt real in large part because we could pass them around, share them and collaborate on moving them. My experience was not with toys but with another person.

"Our goal is to make virtual communication even better than real-world communication," Luckey said. "VR is the only thing that will get us there."

The time is coming when, if someone says, "Let's meet," everyone will know that means let's meet in VR. The default mode of VR is "together".

Very soon, perhaps in five years, the bounded worlds within virtual reality will begin to be networked together into distributed virtual worlds. When you're wearing the visor of an augmented- or mixed-reality system such as Magic Leap, HoloLens or Meta, it maps the local environment. To make, say, a virtual teacup appear on your real table, it needs to know where your table is. The visor uses outward-facing cameras and sensors to scan your environment to create this map. Magic Leap (among others) is working on protocols that save a mapped place in the cloud so it doesn't have to be remapped for each encounter. Your unit merely needs to register and update any changes in the space. This in turn will let you share virtual objects across different surroundings, even if participants are in distant places. Someone in Barcelona can drop a virtual flower into your virtual vase in Chicago. Because artificial reality is inherently social, its environments will be inherently social and networked.

That's not to say this will be easy. Don't let the relatively portable size of VR and MR wearables fool you. As they get smaller and lighter, the infrastructure behind them must grow larger and larger. The scale of the servers, bandwidth, processing, storage and cleverness required to run networked virtual places at the scale of the planet for billions of people is beyond big data. It is ginormous data.

Which raises another issue: every virtual world is potentially a total surveillance state. By definition, everything inside a VR or MR world is tracked. After all, the more comprehensively your behaviour is tracked, the better your experience will be.

During a virtual journey, whether it lasts two minutes or two hours, the things your gaze lingers on, the places you choose to visit, how you interact with others could all be captured to customise the experiences to your preferences. But many other uses for this data are also obvious. It could be used to sell you things, to compile a history of your interests, to quantify your actions for self-improvement, to personalise the next scene, and so on.

As far as I can tell, there are no VR systems that currently store the data they track or do anything with it. While companies are aware of this potential, they are simply too consumed with getting the virtual worlds to work to bother with exploiting the data feed. Inevitably, however, some will graduate to view this immense trove of personalised data as a commercial treasure. The puzzles of its legal status, who has access to it, what government claims apply and what can be done with it will occupy us as a society in the future. It's easy to imagine a company that succeeds in dominating the VR universe quickly stockpiling intimate data on not just what you and three billion other people favourite but what you do on weekends, what people you pay attention to, whether you're depressed, and so on. To do that in real life would be expensive and intrusive. To do it in VR will be invisible and cheap.

The creation of global artificial reality is an enormous project, and its adoption will start slowly. In every VR demo I tried in the past few months, I needed assistance to get the gear on and adjust the fit. Most demos required spotters to watch me. There were straps to deal with, cords to trip over, furniture to avoid. The software was glitchy. "Right now VR systems, particularly the tracking, don't work without constant technical maintenance," says Jeremy Bailenson, who directs the Virtual Human Interaction Lab at Stanford. "I've been running VR for 20 years, and the bane of my existence is driver updates."

Some of these problems are the growing pains of the prototype phase. But there are also some fundamental features missing. Chris Dixon, a partner in venture capital firm Andreessen Horowitz, who led his company's early investment in Magic Leap, thinks VR will follow the flywheel effect: sluggish to start, its momentum slowly compounding until it's unstoppable.

As the flywheel begins to turn, friction will hinder its rotation. But those friction points are also fresh opportunities. These are problems whose solutions will enable many other innovations. Any of the following pain



The team uses Beam robots to collaborate – for now

points might be the opening that produces the first VR billionaire:

The dork factor. There's no getting around the fact that everyone looks like a dork wearing a head-mounted display. The failure of Google Glass was in large part due to the fact that you could not pass the cool test wearing one. The form factors of VR and MR have a way to go before they become culturally invisible.

Safety. I nearly fell in a recent VR journey because I tried to jump into a pit that wasn't really there. Oculus weirdly warns its users to "remain seated at all times". The problem is, if you're present – really present – in an alternative place, you're absent from the place your body is. That's a recipe for accidents. Mixed reality, where the room you're actually in remains visible, can diminish the clumsiness between realms but doesn't eliminate it. Then there is our ignorance of the long-term effects of fooling your mind and body. This is so new we don't even know yet what questions to ask.

Inadequate interface. At this moment in its development, VR is at the same infant stage as early PCs that required a command-line input. There are no intuitive tools for easy creation. The VR industry is waiting for its Doug Engelbart to invent the equivalent of the mouse. This is perhaps the most critical missing piece preventing a rapid take off. Without an interface that anyone can grasp in minutes, content can be made only by the truly dedicated.

Nearly all of the non-movie VR experiences uploaded to date were created using a computer-game engine from either Unity or Unreal. All these first-generation experiences were created with 2D tools – screen, windows, mouse. But VR cannot reach ubiquity until the tools for VR creation live in VR itself. The first steps towards native tools were announced this spring. Both Unity and Unreal have demoed a VR version that permits users to make VR in VR. However, to foster a smooth transition, the VR versions of both creation engines import 2D metaphors (like menus) – the equivalent of a command line – into VR. Still missing is the breakthrough insight that takes advantage of VR's peculiarities to deal with VR's complexities.

I had an aha moment inside a VR app called *Tilt Brush* that was purchased by Google. I was using a brush to paint with light in three dimensions. I was inside my creation, moving around with my body, working up a sweat. It was the most fun I've had in VR. And it's not just for fun. Trials at Google revealed *Tilt Brush* could be an ideal prototyping tool. In a few minutes, an untrained person could sketch a design and you would instantly *see* it.

My aha was that, at its root, VR is as much a creation tool as a consumption tool. VR is in line to reduce the barriers to creation even further.

Fame awaits the genius who figures out the elegant VR interface for VR creation. The tools would allow you to manipulate 3D space with minimal gestures, voice and gaze. I suspect there would be a beauty in watching a skilled creator work in VR, much like in watching a woodworker or dancer.

Narrow field of view. Right now the view in MR devices is too narrow. Of the current crop of MR spectacles, Meta 2's field of vision is the widest, but even its coverage is inadequate. Virtual objects that are located in front of you, within the coverage of the screen, appear present. But when you turn your gaze away, they disappear from your peripheral vision. This breaks the chain of persuasion. Fully enclosed VR devices don't suffer the same drawback; because you see nothing in your peripheral vision (only blackness), you don't get contradictory information. Objects disappear when you turn, but the background area does too.

All MR systems labour under a second challenge that VR systems don't: ideally, in a mixed reality, the virtual teacup you see on your desk would be lit in the same way as your real desk. The mismatch in the lighting is another weak link in the chain of persuasion.

Tethers. It's hard to overstate the benefit of a lightweight device that allows you to roam freely. Screens and processors can be made much smaller to fit into glasses, but batteries are the problem. It'll be a long time before a day's worth of power can be squeezed into the frames of glasses. For now they will be wired to a battery in your pocket.

The co-evolution of science fiction and innovation is slowly being recognised as a paramount cultural force. Talk long enough to any engineer working on virtual reality and they will eventually mention the book *Snow Crash*.

Among the first people Abovitz hired at Magic Leap was Neal Stephenson, author of *Snow Crash*. He wanted Stephenson to be Magic Leap's chief futurist because "he has an engineer's mind fused with that of a great writer". Abovitz wanted him to lead a small team developing new forms of narrative.

"We've maxed out what we can do with 2D screens," Stephenson says. "Now it's time to unleash what is possible in 3D, and that means redefining the medium from the ground up." He compared the challenge to crossing a treacherous valley to reach new heights. He admires Abovitz because he is willing to "slog through that valley".

It's too early to know what virtual reality is or what it will be. Abovitz believes that synthetic reality is the ultimate human medium because it is so directly wired to our brains. "Our brain is an amazing sensory computer. Magic Leap is just the tool for a power that people have had brewing in them since people first appeared." One thing we do know: the evolution of technology can take curious turns. Cell phones started out so bulky they needed their own luggage. It was easy to imagine them getting smaller. But they did not merely shrink into miniature versions of themselves. As it got smaller, the mobile phone lost its keypad, gained a hi-res colour screen, started to grow in size again and stopped being used as a phone. It evolved into something unexpected. VR will surprise us too.

Not immediately, but within 15 years, the bulk of our work and play time will touch the virtual to some degree. Systems for delivering these shared virtual experiences will become the largest enterprises we have ever made. Fully immersive VR worlds already generate and consume gigabytes of data per experience. In the next ten years, the scale will increase from gigabytes per minute to terabytes per minute. The global technology industry will all struggle to handle the demands of this vast system. The bigger the virtual society becomes, the more attractive it is. And the more attractive, the bigger yet it becomes. These artificial-reality winners will become the largest companies in history.

I don't know if Magic Leap will be one of those companies. It's not going to win the race, but none of the current titans were first to their markets. Magic Leap has filed more than 150 patents, but it has not yet publicly demoed a prototype. Most important, we still don't know enough about human perception to know what will work in virtual domains; it'll take more VR to figure that out. We must navigate the treacherous valley before reaching new heights.

Yet something has happened. A threshold has been crossed. After a long gestation, VR is good enough to improve quickly. It's real.

Kevin Kelly is senior maverick of WIRED*'s US edition and the author of* The Inevitable*, out in June*

After the co-working boom, co-living is a logical next step. WIRED moves in for a week to embrace an emerging trend (linen included)



By Rowland Manthorpe
Photography: Brian Finke



Jeremy Schrage, Common resident



Anu, financial marketing

Home-as-a-service

Mike Dillon needed to move house – fast.

The 32-year-old data engineer had been offered his dream job working for a tech startup in New York, and he had three weeks to say goodbye to his parents, friends, car, cat and two-bedroom flat, pack his life into two suitcases and relocate from Lexington, Kentucky.

The prospects for accommodation did not look good. New York landlords usually demand that tenants commit to a 12-month lease – Dillon didn't want to sign one of those without even seeing the place. He could look for a sub-let, but he didn't want to spend his first month in his new job combing listings by day and touring grimy apartments by night. There were hotels. Airbnb. (The $545 per month he paid in rent in Lexington was suddenly looking like great value.) Then, scanning the Williamsburg listings on property website Zillow, Dillon came across a notice for a place called Pure House: "Communal homes... furnished and month-to-month... a nurturing environment."

The Pure House website was a little weird. The application form asked, "What are your passions?" and "How will you be an essential member of the community?". "I was suspicious," says Dillon. But the convenience was unbeatable, the $1,600 (£1,125) monthly rent felt fair – and, for someone with few friends in the city, the offer of community was appealing. Dillon thought about lonely nights in a studio with only Netflix for company. He clicked the link and sent in his application.

Dillon had stumbled on large cities' hot housing trend: co-living. In San Francisco, New York and London, businesses such as Pure House are offering modern nomads the opportunity to switch location with something approaching seamlessness. There's no exhausting set-up, no tortuous trial-by-U-Haul: for a flat monthly rate, you get a bedroom, bathroom, kitchen and linen, with all utilities included.

Perhaps most importantly, you also get access to the community. Residents of co-living houses are "curated" for their suitability and willingness to mingle. That's what makes them different to a regular flatshare – here, at least in theory, everything is taken care of. Even the people are part of the package.

The downside: you have to share. Co-living houses aren't dormitories, but they do involve some degree of cohabitation, whether that's in the bathroom, the kitchen or – in the case of thin-walled Pure House – wherever people are making noise. For many adults, this would be abhorrent. To a generation accustomed to the idea that sharing is caring, it seems less of a compromise.



L-R: Alex Cheng, structural engineer; Anu, financial marketing; Kamilah Gray, media marketing at Bloomberg

"What's being offered to a consumer is, 'We will give you a better living experience for the same price,'" says Arun Sundararajan, NEC faculty fellow at New York University's Stern School of Business. "The trade-off is sharing space, but it is becoming increasingly legitimised as something you pay for."

The movement is growing in scale. In Brooklyn, Pure House has been joined by Founders House, the Loft, Gramercy House and Common, a $20 million (£14m)-valued enterprise set up by General Assembly co-founder Brad Hargreaves. Larger operations are on the way. In Old Oak, north-west London, property developer The Collective has built a 551-room co-living tower block, with further space for 400 co-workers. Co-working decacorn WeWork is also betting big on co-living, with a 200-room building in Manhattan. According to an investor pitch deck leaked last August, WeWork expects accommodation to make up 21 per cent of its revenue, or $605 million, by 2018.

The overlap between co-living and co-working is no coincidence. Co-living startups are hoping that they can do to residential accommodation what co-working did to office space: attract young people to shared spaces, subverting the economics of real estate by offering access over ownership.

Along the way, they want to clear up the housing crisis – and solve the problem of modern loneliness.

Spanning seven loft apartments across two buildings in the heart of Williamsburg, Pure House is a house in spirit rather than reality. So to maintain community spirit, founder Ryan Fix initiates gatherings himself. On a freezing Thursday evening in February, he rouses the inhabitants over Slack: "POTLUCK TIME, MY PLACE IN 1 HOUR!"

Several hours later, the guests begin to dribble in: a mix of communal dwellers old and new. There's a green-haired Israeli art student who says she came to Pure House to find "a place you can't feel alone". There's also an AOL social media editor, a robotics engineer and an entrepreneur working on a dating app. Plus, of course, burly, bearded Mike Dillon, five months in New York and no longer the ingénue, who arrives bearing three single-serve bottles of wine from meal-delivery service Blue Apron.

Fix, a lithe 41-year-old wearing jeans and a tight yoga top, greets the arrivals with hugs and words of encouragement.

He is the sort of person who is always ready with a recommendation – improv classes, day raves, the fact that you must go to Burning Man. He turns to WIRED. "I love helping people actualise their dreams," he says. "It's my free high."

This is the room where Pure House started, and where Fix has lived since 2010. A former financier and real-estate broker – "too much about money, not really me" – Fix began hosting as a way of meeting like-minded people. When the apartment next door became available, he took that too, as well as several other rooms in the same building. Suddenly, he was in co-living.

Co-living can be traced back through 1960s Scandinavian communes and 19th-century boarding houses. (If Holmes and Watson lived at 221b Baker Street today, Mrs Hudson would be their community manager.) Its modern incarnation, however, has its roots, like so many things, in San Francisco.

For some time, artisans of the city's startup scene have been gathering together to form "intentional communities": communes, done the tech way. These institutionalised houseshares help defray the cost of Silicon Valley living, but also fulfil the high-minded purpose of spreading ideas, forging connections and changing the world.

"We do tech talks, we have dinners once a week, we collaborate," says Jeremy Swerdlow of Rainbow Mansion (tagline: "an intentional community of people working to optimise the galaxy"), set up by three Nasa researchers in 2006. "It's not commercial. This is really sharing a philosophy and a passion."

If these capitalist communes are the mother of co-living, the disreputable, absent father is the hacker house. Many in the co-living movement dislike these cheap, sparsely furnished dorms, which keep costs down and revenues up by packing entrepreneurs and developers in bunks; but their continued existence is proof both of concept and demand. It speaks to a wider problem: the crushing housing crisis afflicting not only San Francisco, but every large urban centre in the western world. A problem Silicon Valley has yet to solve.

The dream of co-living is to combine the energy and spirit of the commune with the commercial effectiveness of the dorm. It sounds simple – but the practice is far from straightforward.

"[They're] attempting to commodify and scale community, which is difficult," says Chelsea Rustrum, co-author of *It's a Shareable Life*. "Co-living started with houses and in homes, so it's really about recreating home."



L-R: Ryan Fix, founder of co-living space Pure House; Mike Dillon, data engineer; Therese-Heather F Belen, analyst at Rocket Fuel Inc, an ad technology firm; Juan Francisco Castro Linares, founder of sports news app, *Mementuum*

When WIRED asks Brad Hargreaves, the founder of Common, if he's ever been to Burning Man, he gives a short, sharp laugh: "No, I have not. The whole thing of sand getting in your hair, not getting a shower..."

It's Super Bowl Sunday, and whereas in Pure House a small group gathers for an evening of cuddling and meditation, a boisterous crowd has assembled at Common's property in Crown Heights, Brooklyn, to drink Bud, eat chicken wings and watch the game. There's not a hammock, fairy light or handwritten motivational note in sight: instead it's all clean white walls, wooden floors and LED filament bulbs. "An interior decorator comes in and everything's perfect," Fix warns beforehand. He means it dismissively; it seems a mere statement of fact.

Away from the hubbub, Hargreaves sits in the kitchen sipping a glass of red wine. A slim, mildly stubbled man wearing a blue shirt, jeans and brown brogues, his contained manner makes him seem older than 29. "One of the misconceptions around co-living is that you're sharing everything – sharing your emotions, being physically intimate – and that's not the case," he says. "I'm not looking to change the way people live. I'm looking to solve a housing need."

Common is the most advanced of the new breed of co-living startups. Since October 2015, it has opened two houses of 19 and 20 rooms, with another 51-room house unveiled in spring, and "numbers four through ten in the works". Venture-backed to the tune of $7.35 million, it works with developers on custom-built co-living houses designed for easy accessibility. For $1,565 to $1,950 a month (there are discounts for longer stays), members can enjoy the convenience of co-living without the crusty ideological commitments.

In order to make co-living palatable to a wider audience, Hargreaves has smoothed many of its sharper edges. Groups sharing bathrooms are split up by gender. The self-help ethos of the commune has been replaced by complimentary linen changes and cupboards stocked with kitchen towels and disinfectant wipes. Even so, the fundamentals remain – sharing, flexibility, and, of course, community.

"I needed a short-term place, plus something that's communal," says Kamilah Gray, a marketing manager for Bloomberg who moved into Common after a work relocation fell through and left her without an apartment. "A nice communal place, not a shitty dorm."







Common Albany, Crown Heights, New York

























Pure House, Brooklyn New York



















"I like meeting people and sharing spaces," says Bryan Bumgardner, who came to Common from Missouri for a three-month programming bootcamp. "That feels more natural than suburbia, with your white picket fence and your 2.5 kids. I grew up watching that suck. I'm not going to be isolated from everyone."

Common has dedicated Slack groups, group events, a community manager and a code of values for its members. In the basement at the first property, also in Crown Heights, six A3 sheets hang at intervals along the wall. At the top, each one asks: "Which Common core value resonates with you and why?" As part of their induction, members take Polaroids of themselves and stick them on a sheet: the choices are "Keep Evolving" (the most popular option), "Lend a Hand" (the least), "Be Present", "Love the Journey", "Stay Curious" and "Open the Door".

Community may be a saccharine cliché, but the need for it is very real. According to a 2010 report by the Mental Health Foundation, 48 per cent of UK adults think we are getting lonelier as a society. Among the young, the "loneliness epidemic" has gone viral: nearly 60 per cent of 18- to-34-year-olds told the Mental Health Foundation they felt lonely often or sometimes.

Changes in housing are bringing people closer together. In 2000, 25 per cent of US adults lived with flatmates; by 2012, it was 32 per cent, according to research by property website Zillow. In large metro areas such as Los Angeles and New York, 48 and 42 per cent of people respectively live with people who aren't their partners.

Yet human contact remains hard to find. A dizzying array of apps promise to provide meaningful connections, but for every *Bumble* date or *YPlan* gig there is a disproportionate amount of time spent scrolling, alone. "The benefits of being around an in-person community are accelerated and heightened by the amount of time we spend in front of our digital devices," Hargreaves says. "These places are set up for building communities, for people to get to know each other."

To build community, of course, you need community-spirited people. Like all co-living startups, Common operates a selection process: an online form followed by a video interview. And, like all co-living entrepreneurs, Hargreaves is not keen to talk about it. (At the end of one interview, a founder asks if "there is a way not to talk about turning people away, because we like to be inclusive".) Common, Hargreaves maintains, is "first come, first served". "We don't want to



L-R: Ryan Fix; Steve Tebbe, data scientist at IBM

get in the business of pre-selecting the best people – that would create a weird culture and environment," he says. At Common they prefer the term "curation": that implies the right level of care and consideration, without creepy overtones of exclusivity.

Besides making the mechanics of community-building uncomfortably evident, the issue of selection raises difficult questions about the tension between profit and purpose. Co-living operations are torn between filling the space and safeguarding the community. You have to have the right people, or the central selling point is lost; too few people, and the business side suffers.

In June 2015, co-living startup Campus closed 34 houses, with its founder Tom Currier, a Peter Thiel Fellow, admitting that "we were unable to make Campus into an economically viable business". One of the biggest problems facing Campus, according to residents, was the power it gave the community – such as members voting on new entrants.

"It really hindered people moving in," says Annelie Chavez, a Campus community manager, now living at Common. "With Common you trust the team to make that decision and it fills the rooms much more quickly."

Can a self-selecting cadre of privileged young professionals really call itself a community? "The gentrification issue," Bumgardner calls it. He makes a face. "I feel bad about it, but where am I supposed to live?"

"I'm conflicted," says Daniel, a 20-year-old who dropped out of college to take a software development course in New York. "It's gentrification and I'm part of the problem, but there wasn't much opportunity for me to not do that."

But on Super Bowl night, such worries can be left for another time. After the game is over, several Commoners head to the garden, where a high wooden fence surrounds a pristine set of white-cushioned wooden furniture. It is impossible to see over to the other side. But inside, the Commoners smoke, laugh and shout. They are young, here and having fun: if this isn't community, then what is?

The biggest question for co-living isn't "can it work?", but "can it scale?" Is it a niche option for latter-day hippies, or a way of housing a genuine mass of people? In a shabby suburb of north-west London, Reza Merchant, founder and CEO of The Collective, is putting that question to the test.

When it opens in May, The Collective Old Oak will be the biggest co-living development in the world, with 551 rooms, including 452 "twodios" – flats with two single bedrooms, shared shower and kitchenette – and 1,114m^2 of collective space, as well as 400 co-working spots.

"I don't mean to sound arrogant, but we're clearly pioneering co-living," Merchant says. "We started back in 2011, so we've been curating spaces for years."

That was the year Merchant, 27, the son of immigrants from India, used his parents' home as security to borrow £1.8 million in order to buy a derelict hostel in Camden, which he renovated and turned into serviced apartments. The gamble paid off: Merchant now has six residential buildings and three co-working spaces, all in central London, with another Old Oak-sized development to come in Stratford in 2018.

Merchant won't reveal how much Old Oak cost to construct, but says it is in "the several tens of millions". When WIRED visits in January, it is in the final stages of construction. Speaking over the scream of buzzsaws, Merchant shows the final location of the ground-floor restaurant, bar, lobby and grocery shop. A tall, slim man with a lordly manner (he made a brief appearance on reality-soap *Made in Chelsea*, where he was sold as the top lot in a charity auction), he manages to look elegantly bored even in his hard hat and high-vis jacket, which he wears draped over a long coat and double-breasted blue suit. "It's going to be heaving," he says.

Upstairs, it won't take much to create a crowd. Each bedroom has space for little more than a bed, a chair and a wardrobe. (There will be additional storage space at the back of the building for items such as suitcases.) "The idea is that these are essentially the crash pads," Merchant says. "Your living room is all of the communal space."

He points out the shared kitchen, the secret garden sitting room, the "disco

launderette" where people can party while they wash. "You're getting access to so much more than if you were living in a house with five or six people."

It's the same equation behind all co-living developments – the smaller the rooms, the bigger the communal space – taken to its logical extreme. And if anything, this seems to be the direction co-living is headed. Co-working giant WeWork is preparing to move into accommodation, and as always, it's doing it at scale.

According to a leaked investor pitch deck, WeWork's founders Adam Neumann and Miguel McKelvey plan to use the $400 million they raised in June 2015 to fill 69 WeLive locations with 34,000 members, all by 2018. The first WeLive will occupy 200 rooms on the upper floors of 110 Wall Street, a 27-storey skyscraper a block away from New York's East River. Other reported developments include similar sized projects in Brooklyn and Washington, DC.

McKelvey declines to comment on the accuracy of these projections. "Our focus is on 110 Wall," he says. "Once we've got it, then I think the whole world will be open to us, and we're confident about that."

A rule of thumb in co-living: the bigger the building, the blander the style. At WeLive, this means pegboard walls, exposed pipework and upbeat posters preaching "Home is where the Wi-Fi is". In The Collective, the rooms are decorated in three distinct themes: Loft, Hotel and Nordic – the difference in each case being the colour of the otherwise identical floor and furniture. The air in both is of a student hall of residence.

According to the Mayor of London's London Rents Map, the weekly median rent in Old Oak's postcode is £142. With rents for The Collective starting at £220 a week, isn't Merchant worried these places won't get filled? Do earning adults *want* student accommodation?

As the tour goes on, the scale of the enterprise becomes clear. Yet Merchant's confidence never wavers. "[Success] is a state of mind: if you believe something enough, it will happen. What's the point of thinking about something that's never going to happen?"

At times during WIRED's six-day stay in Pure House, it is possible to see the dream of co-living in action. In a strange city, it's good to have people around. As one ex-resident puts it: "You're acknowledged when you come home."

Yet despite this activity, the viability of Pure House seems precarious. Having had 25 apartments, Fix is now down to seven, and will soon be reduced to four. He is representing himself at the New York City Housing Court, accused by one of his landlords of running a business in a residential space. He has dark circles under his eyes; at times, he says, his hands shake.

131

For Fix, the heart of the matter is the conflict between community and structure. Community has to be made by the people themselves – by introducing rules and structure, he is only getting in the way of that. That is why he resisted the formal structure that could have made his life simpler.

But for a business to grow, it must become impersonal. The CEO stops knowing every customer. Then they stop knowing everyone in their company. Eventually, the personal relations disappear: there are customers who receive a service, and although people staff the system, the system is greater than any one individual.

Co-living entrepreneurs look forward to the time when they can turn housing into such a system. "Living as a service," Merchant calls it. In this vision, co-living spaces are the "platform" on which people rest briefly – "live much more lightly", as McKelvey puts it. Everything will be rented, nothing will be burdensomely owned. Buying furniture, for example, will be unnecessary: McKelvey puts it in the category of "things you don't really need to have".



L-R: Reza Merchant and James Scott, CEO and COO of The Collective

Co-living operations are torn between filling the space and safeguarding the community

"Look at the music industry," says James Scott, The Collective's 23-year-old COO. "Ten years ago the value was in the physical piece of music. Nowadays, people want to consume music for free, so the music industry needed to monetise the community.

"If you apply that back to co-living; if the value is in the community that are in these spaces, I monetise the community. That means I don't have to monetise the space any more."

The Collective plans to partner with organisations to offer every conceivable add-on, from transport (Zipcar) to financial planning (Nutmeg) to "wardrobe as a service" – meaning clothes as part of the package. By selling access to his community this way, Scott anticipates that he will be eventually be able to offer accommodation without asking for payment.

"In the midst of an affordability crisis, we'll have delivered free housing, because of the shift in attitude as to where value's created. And that is super disruptive, and really exciting."

Fix rates communities according to their members' involvement and commitment. But what looks to him like a weak community is really a different notion of community altogether: one that is not bound to a place, or people, but instead belongs nowhere, and is linked to you personally, like friends on Facebook or documents in the cloud.

"We're slowly decoupling all of those things that tie you back to your physical space," says Scott. "The bubble in which you live is completely separated from the space in which you live in."

It's a vaulting – and not implausible – vision of the next stage of the networked society. Yet despite claiming to be a solution to social isolation, it sounds lonelier than what came before.

On March 1, 2016, Mike Dillon left Pure House for the last time. He had met someone – on *Tinder*, incidentally – and they were moving in together.

The move has not been pleasant. "Instead of the intimate questionnaire of, 'What's your passion, what are you here for?', it's 'Can we see inside of all of your bank accounts, please?' Almost violating," says Dillon. But now he is able to reflect on the experience.

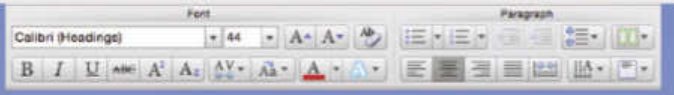
"At times it felt regressive," he says. "I had been living alone and in my thirties. But it was what I needed. I'd do it again. It was a great transition."

Was he part of a new social movement? Witnessing the end of loneliness and the start of a different way of living? For Dillon, these questions seems less important than the practicalities of finding a place to rent: "It was attractive compared to the alternatives," he says. "It's a free market. The invisible hand guided me into Pure House." W

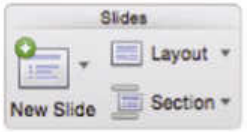
Rowland Manthorpe is WIRED*'s associate editor*

PHOTOGRAPHY: NICK WILSON





Slides Outline





Click to add title

By Russell Davies

PowerPoint: you hate it, right? But bear with us.
To mark its 29th birthday, WIRED offers
29 bullet-points in the PPT slide's defence







PowerPoint has been blamed for declining standards of literacy and corporate failure

1.
When we understand that slide, we'll have won the war
–
General Stanley McChrystal (WIRED 03.15), the leader of Nato and US forces in Afghanistan, was once confronted with an intricate PowerPoint slide detailing American military strategy (*see right*). "Once we understand that," he said, "we'll have won the war." This was not the first time someone had complained about a PowerPoint slide, and it would not be the last. But his statement was more profound than he knew, because the real mystery is not so much, "Why is that slide so complicated?" but more, "How come the Army is using PowerPoint?" Or indeed, "How come almost every organisation in the world is using PowerPoint to communicate almost everything to almost everybody?" That's the real question. How come PowerPoint is everywhere? How has it been so successful for so long? How has nothing ever replaced it? Once we've understand that, we'll have understood the modern world.

2.
One billion installs can't be wrong
–
Microsoft claims PowerPoint has been installed more than a billion times. Very few of those installs were free. People paid for it. They still do. You could make a compelling case that PowerPoint is one of the most successful and influential pieces of software ever created. Yet its role is to be the butt of jokes, the instigator of sighs, groans and eye-rolling. PowerPoint has been blamed for declining standards of literacy, corporate failure and the *Columbia* disaster in 2003. "Death by PowerPoint" was meant, in that case, literally.

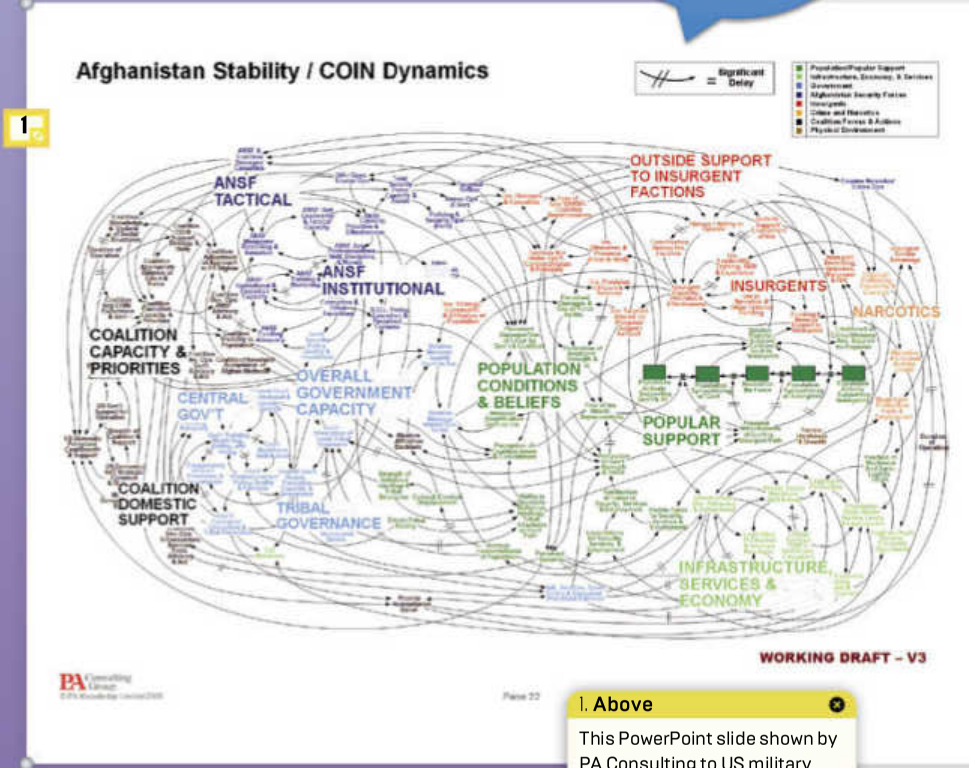
3.
Biro, Hoover, PowerPoint
–
The anthropologist and designer Georgina Voss explains PowerPoint's success in this way: "PowerPoint has become the default for what a presentation is – more than just 'Biro' or 'Hoover' describing any ballpoint pen or vacuum cleaner, but actually moulding in its affordances and use behaviours such that using any non-PowerPoint program becomes more difficult. People in the global north who have come through standard schooling and workplaces understand, broadly, how to use PowerPoint."

4.
It's PowerPoint, even if it's not
–
PowerPoint is so dominant that most of its competitors – Keynote, Google Slides – aren't even challenging its basic model: a linear flow, one "slide" at a time, images and words.

5.
The rhetorical power of visual speech
–
Katrina Sluis is the digital curator at London's Photographers' Gallery. In January 2016, she put on a show featuring artists and thinkers "responding" to PowerPoint. She believes PowerPoint has also been surfing a cultural wave for the past 29 years: the growing importance of the image. "It's the arrival of visual speech, in a way, which you kind of see with the camera phone," she says. "And the way in which, in the attention economy, the image is reified. Images have a kind of rhetorical power in contemporary culture now."

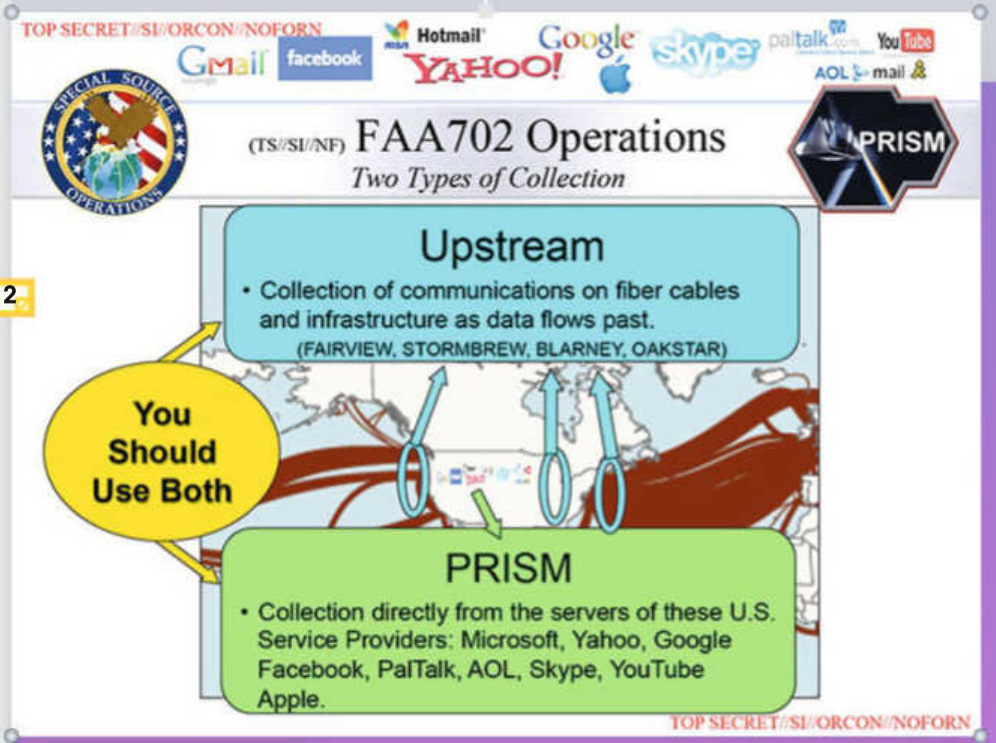
6.
Presentation as therapy
–
Sluis's show reveals something about PowerPoint – that it lets you share ideas by playing with images. "It's therapeutic," she says. "PowerPoint mixes the corporate with the possibility of creativity and personal expression. I wonder if that explains its persistence, the tension between corporate aesthetics and the potential to insert a slide of your kids to hammer your message home."

"WE'LL HAVE WON THE WAR."



1. Above
This PowerPoint slide shown by PA Consulting to US military commanders in 2010 illustrates security, economic and political conditions in Afghanistan. Nobody understood it.





2

2. **Above**

In 2013, the NSA produced a series of PowerPoint slides to explain its top-secret PRISM programme, which allowed US intelligence agencies to gain digital information on foreign targets operating outside the US. This is one of many released slides. They were all as badly designed as this.

7.
It's what everyone has...
-
Stefanie Posavec is a designer and illustrator based in Brixton, London. She works with clients big and small, and says that they all have one thing in common – PowerPoint. It's the design tool that everyone has. "If you design something for somebody, they say, 'I don't have a design program, but I do I have PowerPoint. Can you make me a brochure that works in PowerPoint so I can change it? – because that's the only way that I know how to work with images,'" explains Posavec.

8.
...and it does the job
-
As a way to work with images, it's pretty damn good. It can't do everything, but it does enough. The singer and artist David Byrne loves the way it lets you work with images quickly – and he enjoys its restraints: "When you pick up a pencil you know what you're getting – you don't think, 'I wish this could write in a million colours,'" he says.



Above: *Sea of Possibilities* from David Byrne's PowerPoint art book *E.E.E.I.*

9.
Lingua franca
-
PowerPoint is how organisations communicate. Email someone a PowerPoint file and there's a high chance that they'll be able to open it. Most organisational knowledge is probably stored in PowerPoint files. Microsoft understands this power, of course, and it works very hard to make PowerPoint backward compatible. You can open a PowerPoint 3.0 file from 1992 in today's version on an iPad Pro and all the animations will run just as intended.

10.
Landscape trumps portrait
-
PowerPoint's versatility and ubiquity means that it is now used for everything, not just presentations. As a result, organisational aesthetics have shifted from the traditional vertical "portrait" world of the A4 document to the horizontal "landscape" world of the desktop monitor – and the PowerPoint slide print-out. All the words that used to go into a document now get crammed on to a slide.

11.
This is why we can't have nice things
-
Robert Gaskins, the man who invented PowerPoint, never intended that. As he told *The Wall Street Journal* in 2007: "A lot of people have given up writing documents. They just write presentations, which are summaries without the detail." He was never guilty of that himself. The original business plan for PowerPoint was 53 densely worded pages, with a dozen accompanying slides.

12.
Concertinas
-
If you're a presentation nerd, you will have found your way to the archives of robertgaskins.com and discovered a meticulous, creative and imaginative man. The kind of man who invents a piece of groundbreaking software, retires, discovers an enthusiasm for the concertina and immediately builds concertina.com, a comprehensive and detailed resource for concertinists everywhere.

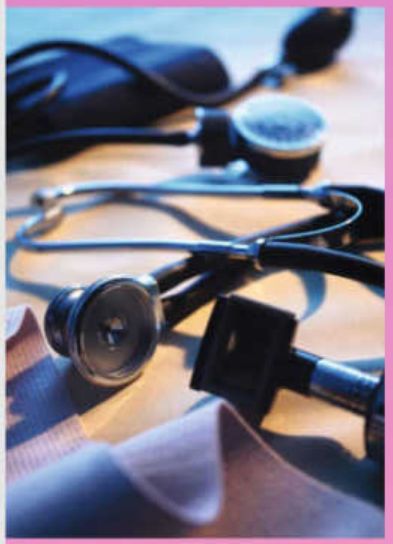
13.
Bullets
-
Your inner-presentation nerd may also be delighted to discover that he's written a history of PowerPoint called *Sweating Bullets*. And you'll read it and realise that the real story is not the one you were imagining.

14.
PowerPoint in the age of mechanical reproduction
-
Robert Gaskins invented the software while presentations were still being done with slides and overhead projectors. He imagined an age of visual computing and created a tool that would exploit it. He concentrated on creating a tool for self-expression and built a product, that, arguably, led the adoption of graphical user interface (GUI) computing – not one that piggybacked on top of it.



Below: PowerPoint allows those giving the presentation to express their ideas creatively. Inserting a photo of your kids or clip art to make your point skews the corporate aesthetic

'It's therapeutic. PowerPoint mixes the corporate with the possibility of creativity and personal expression'



15.
It's a creative tool
–
Gaskins' first big and non-obvious idea was the amount of creative control he would put in the hands of his users. "The primary benefit that PowerPoint aimed at, from the start, was to put effective control of presentations into the hands of people who were expressing their own ideas," he tells WIRED. "Before personal computers, presenters worked through secretaries and graphics 'producers', and then early personal computers were similarly used for presentations through technical specialists (except by a few enthusiasts). All these intermediaries frequently blurred the message and introduced delays that made it fairly impractical to get everything correct. I thought that 'visual' personal computers, such as the Macintosh and Windows PCs, would make it possible for the people who had the ideas to directly produce all the material for their own presentations, so as to express their ideas quickly and accurately."

16.
Ideas, not information
–
Gaskins was building a tool for what he called "content-originators". They wanted to communicate ideas; he wanted them to love PowerPoint. "You can see this motive called out in the very first description of PowerPoint that I ever wrote... almost three years before PowerPoint 1.0 shipped. In the list of proposed 'user benefits', the culminating line is: 'Allows the content-originator to control the presentation.' The term 'content-originator' was the best I could devise to mean 'business people responsible for thinking up ideas and gaining assent to them'. A word like 'executive' or 'knowledge worker' sounded too much like a bureaucrat, and that didn't capture my idea of the people who would most intensely love PowerPoint. A bureaucrat churning out boilerplate doesn't care that much about the details of quality, but a thinker trying to gain assent to an original idea cares passionately about giving it the best shot possible, because the result makes a real difference to the presenter's personal and business success."

3

Review of Test Data Indicates Conservatism for Tile Penetration

- **The existing SOFI on tile test data used to create Crater was reviewed along with STS-87 Southwest Research data**
  - **Crater overpredicted penetration of tile coating significantly**
    - **Intial penetration to described by normal velocity**
      - Varies with volume/mass of projectile (e/g 200ft/sec for 3cu. In
    - **Significant energy is required for the softer SOFI particle to penetrate the relatively hard tile coating**
      - Test results do show that it is possible at sufficient mass and velocity
    - **Conversely,once tile is penetrated SOFI can cause significant damage**
      - Minor variations in total energy (above penetration level) can cause significant tile damage
  - **Flight condition is significantly outside of test database**
    - **Volume of ramp is 1920cu in vs 3 cu in for test**

BOEING 2/21/03 6

3. **Above**

Edward Tufte, Yale professor of visual communication, used this slide to suggest that PowerPoint kills: it's from a report into tile damage during the Space Shuttle *Columbia* launch that obscured the urgency. Days later, the spacecraft exploded.

17.
Social skills
–
Gaskins also knew that making a creative product required something more than the typical group of Silicon Valley developers. "While never compromising on computer science knowledge and ability, I tried to find people who also had broader interests, including social skills and communication skills," he says. "We hired developers with undergraduate and graduate degrees in liberal arts or science disciplines as well as computer science, and with experience of many different kinds, both academic and commercial.

"The people we were looking for were unusual. To find them, we tried to attract the smartest people, with a variety of backgrounds and with broader education and skills than most software startups. The difference in our people should be a big part of the reason for PowerPoint's success."





18.
The best way to get the best team
-
A huge body of evidence is emerging that demonstrates that the best way to improve the performance of a team is to increase the number of women in it. Maybe that too is part of the explanation for PowerPoint's success: "Out of the original 69 people on the complete PowerPoint roster (extending from me to the last person hired while I headed the group, eight years later), half (48 per cent) were women; 70 per cent of all women were in technical positions, and out of all our technical people, 43 per cent were women," Gaskins says. He estimates the average proportion of women in technical positions at the time was about ten per cent and today is around 20 per cent.



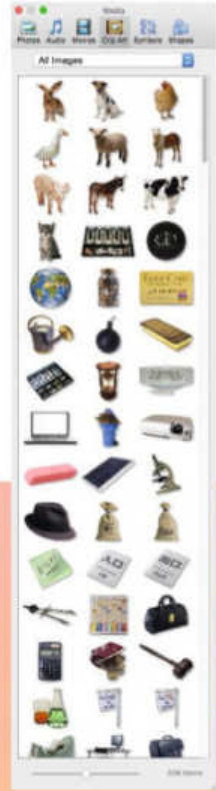
19.
You didn't buy a computer and get PowerPoint, you bought PowerPoint and got a computer
-
If the new "visual" world of computing was going to take off, and for the GUIs of products such as the Mac and Windows to seem worth buying, there would need to be a product that justified the extra cost. Word and Excel weren't going to be it – you could use them via MS-DOS. PowerPoint was that product. A business could take the budget it would normally give a supplier to make slides, and spend it on PowerPoint and the computer and printer they needed to go with it. They bought PowerPoint and got the PC revolution thrown in for free. "For the first big breakthrough version of Windows (version 3.0, shipped mid-1990), Microsoft consciously focused on PowerPoint as the 'killer app' that would provide the incentive to buy a new Windows 3.0 machine," Gaskins says. "Bill Gates used pre-release versions of PowerPoint at large meetings of developers to show off what dazzling colour apps would be possible on Windows 3.0."

20.
Theatre – part one
-
All of this added up to a new form of expression. Slideshows and overheads had existed in corporate life before, but they were so hard to produce that people didn't make them personal. PowerPoint turned it into something more like theatre. "I had studied drama for more than a decade, and I had read Erving Goffman's book *The Presentation of Self in Everyday Life*, in which Goffman applies "dramaturgical analysis" to social interaction, using "the extended metaphor of theatrical performance", Gaskins says. "So for many years I had been thinking about everyday social interaction in terms of theatre; and because my own jobs have depended on my making persuasive presentations, I'd thought about how to control them for best dramatic effect."

21.
Theatre – part two
-
Twenty-nine years later, designer Stefanie Posavec concurs. Does designing for PowerPoint feel to her more like designing for screen or for print? She says neither: "It feels like it's a play. It is a really weird way of designing. This is a whole other way of communicating. It's a strange way of thinking about how to communicate a message. It's time-based. So much of it is based on this rhythm, the rhythm of the story. You have big reveals, and you have your jokes where you press the button. You have to figure out what your rhythm is and how you play the PowerPoint machine, like an accordion. Whether you're fast or slow will change the outcome of your presentation." From the accordion to the concertina: the long, strange PowerPoint journey.

'It feels like it's a play. It is a really weird way of designing. This is a whole other way of communicating'

22.
The original bicycle for the mind
-
Apple CEO Steve Jobs once said that the personal computer was like a "bicycle for the mind". PowerPoint was perhaps the first product to make that a practical reality for millions of people.



23.
Nibbled to death
-
The modern world of business apps is very different to the one PowerPoint grew up in. The monolithic integrated suites are being nibbled to death by tiny applications networked via the internet, doing one thing very well and blurring the line between personal and productive in a way that PowerPoint pioneered.

24.
Fight the PowerPoint
-
That will happen to PowerPoint. If you want to collaborate on a presentation, then Google Slides is great for that. If you want to just chuck a bunch of words into an app and have them nicely styled, there are lots of HTML-based presentation tools which will let you do that. There's Prezi for people who prefer a less linear narrative and don't mind occasional motion sickness. Microsoft itself created a product called Sway, designed to be better at some of the things PowerPoint gets co-opted for – book reports, websites, that kind of thing.

25.
Multiplicity
-
But the big, interesting challenge for PowerPoint is the changing technological environment. It was built for a world of PCs. We're now in a world of multiple devices, VR, multiple screens and presentations happening in multiple locations at the same time. To get a hint of what might happen to presentations in a context like this, WIRED visited a company called Oblong in Shoreditch, London.

26.
Slide park
-
John Underkoffler founded Oblong in 2006. He's known for being the designer behind the futuristic interfaces in the film *Minority Report*. With Oblong's flagship product – Mezzanine – he might have found the way to make some of those notions a reality. The first thing you notice in Oblong's demonstration suite is that you're looking at multiple displays, on more than one wall. Mezzanine was conceived for a world where screens are cheap and ubiquitous. At the front of the room, where there would normally be one big monitor, there are three – all showing different things. You can put images alongside each other, and you can compare things on different screens. Oblong says its big clients love this. They can park a slide to one side of the presentation while they go on with the rest of the story. The content then always sits in the customer's mind. That seems simple, but it expands the possibilities of what a presentation can be.

27.
"We make all the pixels in the room universally interoperable"
-
Mezzanine also connects to the screens in your pocket. And lets you escape the confines of a single tool. Underkoffler's team are enthused about the democratising power of this non-linearity. They're trying to "design out" the power dynamics of PowerPoint. The modern meeting has to be about collaboration, not hierarchy, so Oblong is trying to enable a "hive mind – more fluid, more interconnected".

4-5. **Below**

Left: Mezzanine is a spatial operating environment for conference rooms. Using the controls, anyone can rearrange the data, push new data into the flow or highlight points shown on three screens.

Below: In April 2010, Microsoft co-founder Bill Gates embarked on a speaking tour of US colleges. His aim: to convince students around the country to recognise and tackle the world's big issues. To help him along, he fired up his PowerPoint presentation – which consisted of just one slide, showing the decline in death rates for children in the preceding 50 years.

28.
Shuffle
-
WIRED asked everyone on this journey into the heart of PowerPoint what missing feature they'd add if they could. The best idea was from Katrina Sluis, curator at the Photographer's Gallery, London: she suggested the addition of a shuffle button. That would make things a bit more non-linear, wouldn't it? Maybe that's all PowerPoint needs to prepare itself for the next 29 years.

29.
One damn word after another
-
Which is great. Except sometimes you want someone to actually give a presentation. Gaskins is fond of quoting the linguist and psychologist Steven Pinker talking to *The New Yorker* about PowerPoint. "Language is a linear medium: one damn word after another... When properly employed, PowerPoint makes the logical structure of an argument more transparent." That's what people seem to hate about PowerPoint, but it's also its superpower. It forces you to put your ideas in order – that might be a constraint but it's often a good one. PowerPoint invites you to focus, to look at your story and put it in a useful and persuasive order. That so many of us so often fail to do, that is our own fault.

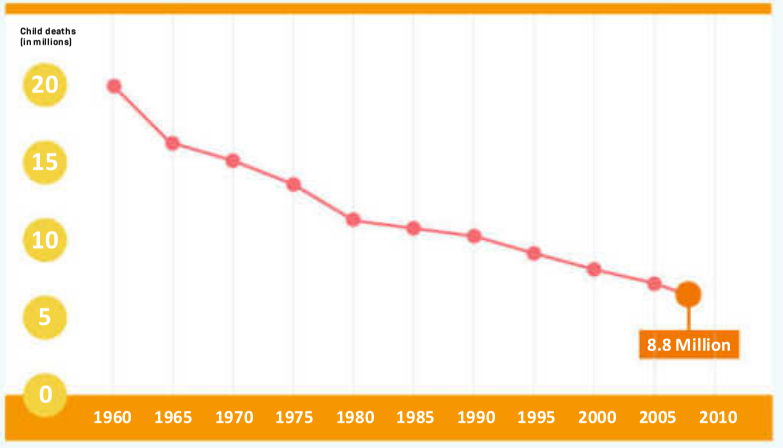


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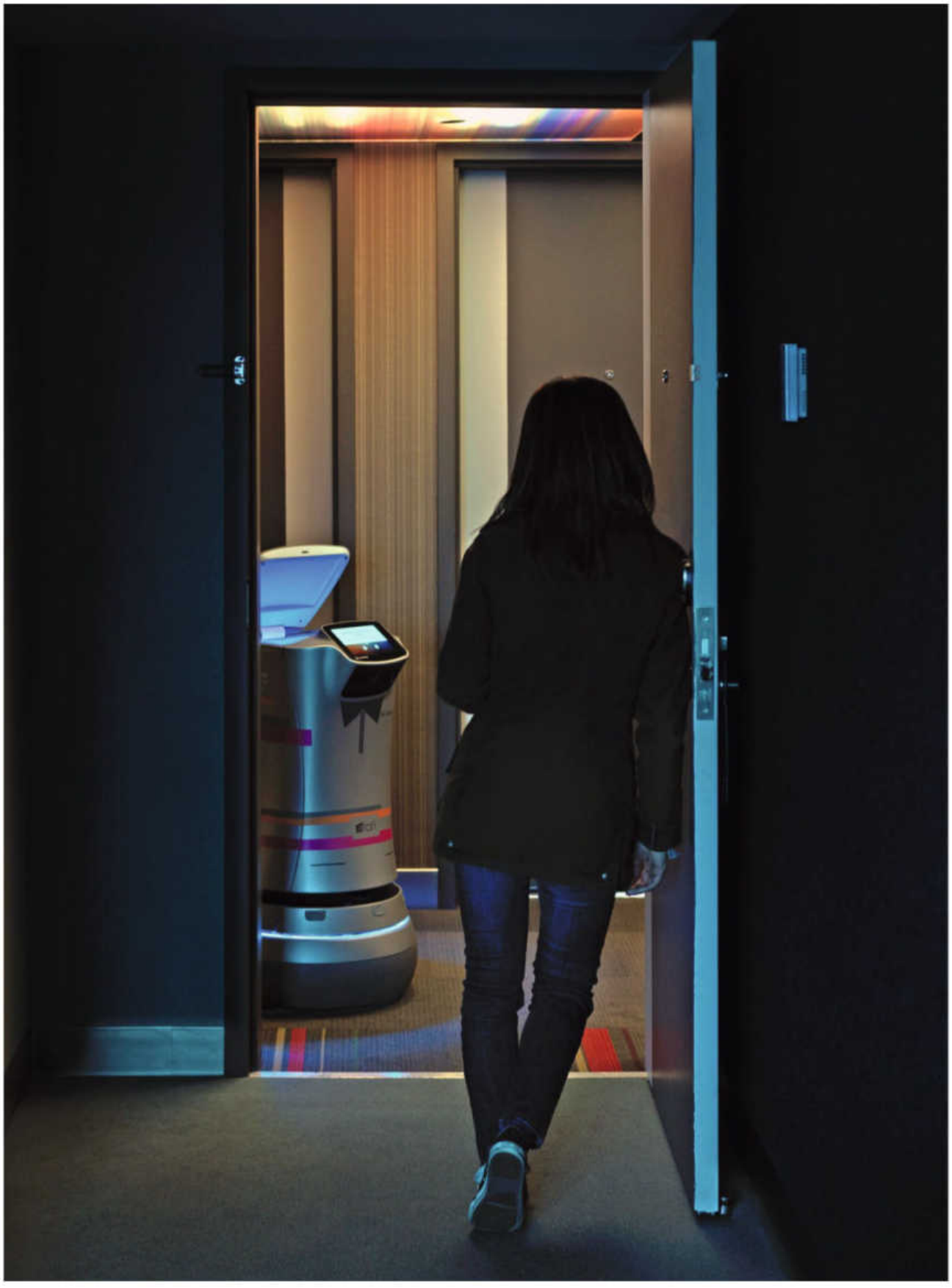
5

Deaths of Children Under Age 5



Citation: 1960 UNICEF, 'Progress for Children' A World Fit for Children. Statistical Review. Number 6 December 2007

***Russell Davies is a contributing editor to* WIRED *and a director of digital strategy at the Co-operative. He wrote about pace layers in* The WIRED World in 2016**



Savioke's Relay delivery robot can tell when a hotel door has been opened, but it cannot recognise the human; she is simply another plane

Service robots are about to
take over the world.
But first, humans need to
teach them how to navigate...
And maybe develop
some decent social skills

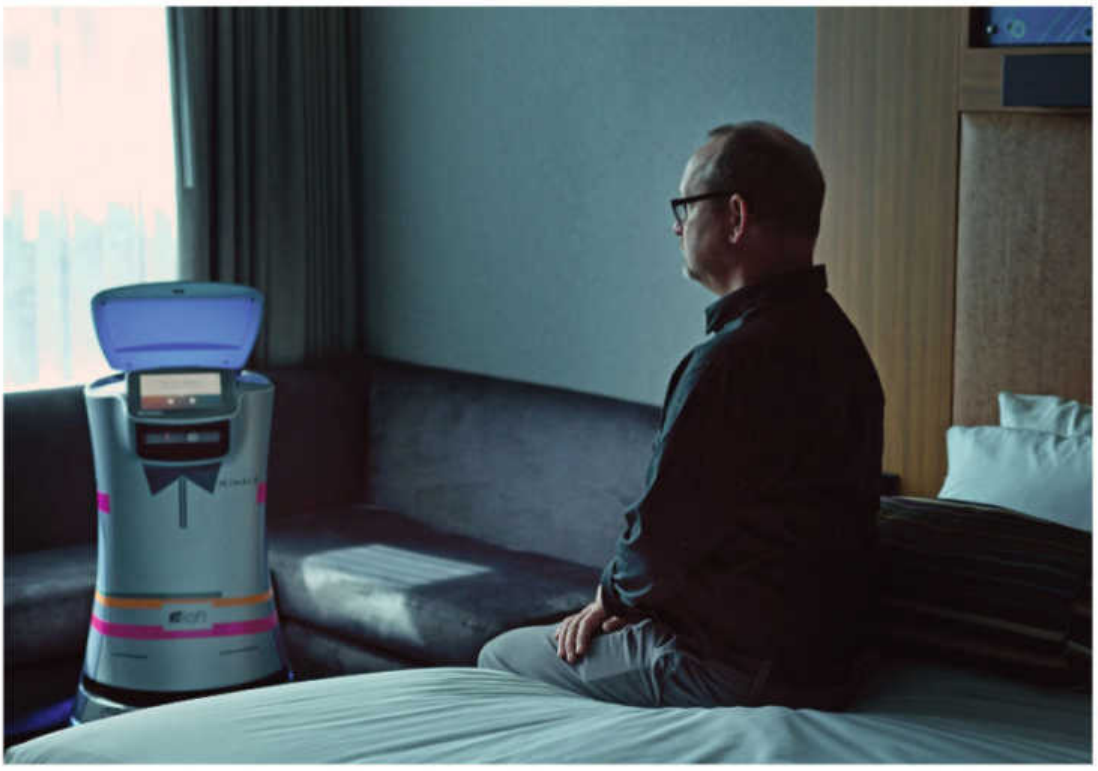
HERE COMES THE (MUNDANE) ROBOT UPRISING

By
TOM VANDERBILT

Photography:
VINCENT FOURNIER



Delivery: Savioke believes its A.L.O. and Relay robots will solve the "last 300 metres" problem of completing deliveries anywhere



Hospitality: the robots are currently used to send small items to guests – A.L.O. (*pictured*) is in a hotel room in Aloft Cupertino

HOW DOES A ROBOT USE A LIFT? It sounds like the lead-in to a bad joke (punchline: "very carefully"). But it's WIRED's first question upon meeting Adrian Canoso, the design lead and co-founder of the robotics startup Savioke, over breakfast at the Crowne Plaza Hotel in San Jose, California.

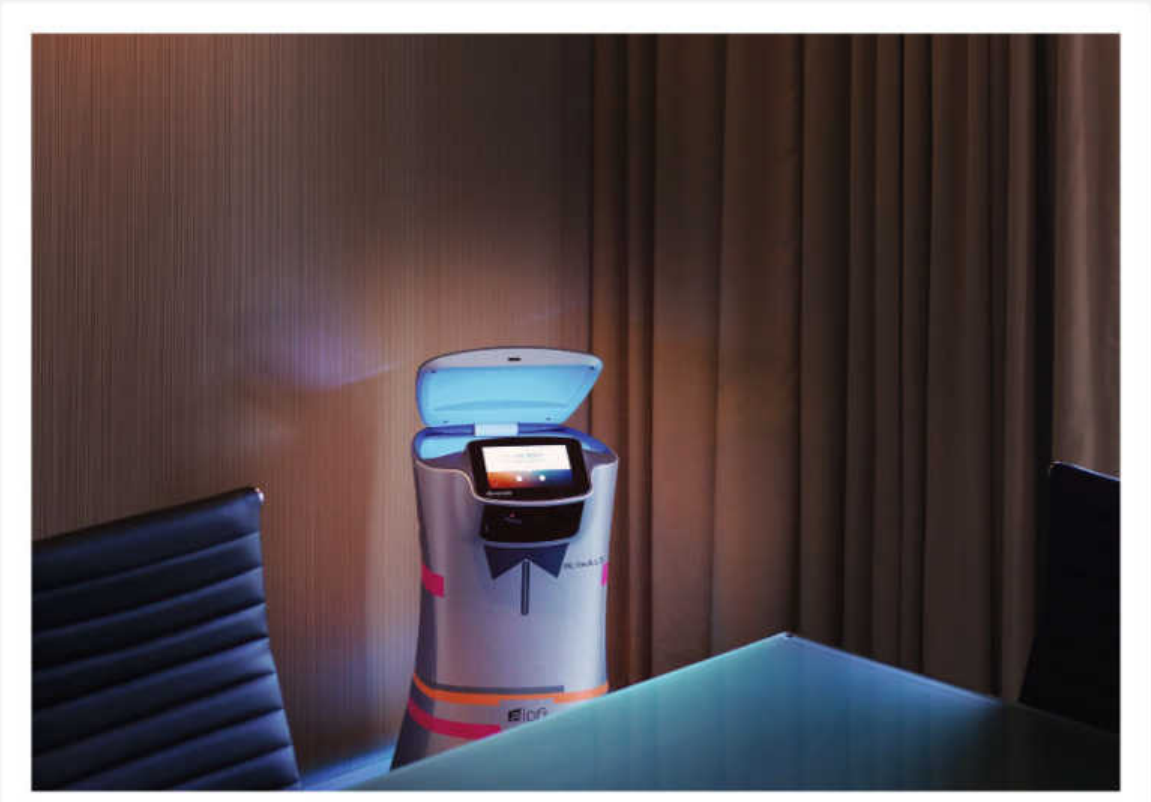
The robot in question is called Relay, an armless device just under a metre tall which ferries small objects (a toothbrush or a bottle of water) from the hotel's front desk to guests' rooms. Technically, the question is rather easy: the hotel's lifts have been retrofitted with a server-supported device that enables the robot to automatically summon them and choose a floor. But there's another issue: the human guest who may be entering the lift at the same time. As Michael Clamann, a research scientist at Duke University's Humans and Autonomy Lab, describes, humans live in a world of social feedback, a world of (usually) clear causes and effects. "If we were in that elevator, you could see me lean forward and touch that button. You know my body language," he says. "I might even ask, 'What floor?'"

A robot choosing floors using unseen machine intelligence, with no visible gestures, might seem magical – or terrifying. Office workers once had the same misgivings about automated lifts; automation technology far pre-dates the widespread public acceptance of automated elevators. Today, we don't even consider that we are stepping into a robot when we enter an elevator. An "actual" robot whirring into an elevator, however, introduces a whole new set of dynamics.

Savioke spent a lot of time figuring out how to make the robot move effectively through the hotel, equipping it with sensors, from Lidar to sonar to 3D depth cameras. Since GPS is ineffective indoors, the whole hotel has been laser-scanned by the robot, with the range of traversable and non-traversable areas stitched together by algorithms (the robot is banned from the second floor, for example, because of an open stairwell). Once summoned, the robot can be despatched by a hotel clerk simply by pressing the room number on its front-mounted touchscreen. "It starts planning its route in real time, multiple times per seconds," Canoso says. "If you stand in front of the robot and then jump out of the way, he might think that object is there for about eight seconds." Then it will try again. If Relay gets held up too long, it alerts HQ.

But the company also spent a lot of time figuring how to make Relay socially navigate the hotel. "We should always be communicating with the robot," Canoso says. When it's on a delivery, a front-mounted touchscreen announces it; this is as much to reassure people as to encourage them not to delay the robot. When it is headed to the third floor, the screen announces the robot's destination. Even Relay's entry to the elevator has been carefully choreographed. "He'll enter gracefully," says Canoso (roboticists tend to refer to seemingly gender-neutral robots with default male pronouns). "He slows down over the threshold, and then turns to face the door, just as a human would." If the elevator is too crowded, he'll wait for the next one.

His very design is meant to communicate intentionality and instil comfort in guests, Cansolo explains. The arched



Security: the bots' hatches can be programmed to open only to its intended recipient

back and the concave chest signify stability. A taper in the centre "reduces the visual volume", making it seem less intrusive. The lines flow toward the back, so "you know what the front is without knowing anything else about it". When it "talks" via the touchscreen, the messages are encapsulated in little speech bubbles; a weirdly human gesture. A pair of eyes – simple black dots that occasionally "blink" – add an empathic touch. But not too empathic. An early iteration had a looping video of a pair of eyes that looked around. If they happened to fall upon an human observer, Canoso says, "people would be like, 'Oh my god, the robot looked at me!'" This was scratched, as was any voice communication. "You don't want to overpromise," he says, "in terms of deeper robot-human interaction."

Until recently, workplace robots have been mostly stationary machines tethered to assembly lines or, as in the systems Amazon Robotics has installed in its specially designed warehouses, powerful, fast-moving automata that operate behind cages in "human exclusion zones", navigating by paths laid out by stickers on the floor. Savioke's Relay, however, is just one of a number of lower-cost robots that are inhabiting human worlds largely as they are. "We're breaking the boundaries on where robots can go," says Canoso, who notes that the hospitality industry is only the first step in Savioke's ultimate business: "a peer-to-peer microdelivery service [to make] the last 300 metres of any delivery more frictionless."

As robots come out of their cages, there is a question of how we will change our world to make it more accessible for robot motion and vision. A larger, more lasting question might be how we will have to adapt to the presence of robots.



ONE OF THE FIRST THINGS YOU HAVE to ask about the hardware," Melonee Wise, the CEO of Fetch Robotics, says, "is will it [accidentally] kill someone?" Her company's robots, she hastens to add, are not lethal. So-called "service robots", she says, are designed to "be around people without being in cages", even if the standards on what constitutes robot safety are not yet written.

Fetch's robots, named Fetch and Freight, are intended to work in large-scale warehouses, the sort that stock consumer goods for online purchase. The former is a "mobile manipulation" robot designed to pluck things from warehouse shelves. The latter is a small trolley-like device that follows a warehouse "picker" as they retrieve the items in an order. These are dropped into the robot's storage space to be whisked off for shipping. Even before one has left, another Freight has arrived to take its place. "Fifty per cent of the time," says Wise, "[warehouse workers] are just doing transportation. Twenty-five per cent of that time, they're just taking back empty carts."

In the company's lab, a good portion of which is set up to resemble a prototypical fulfilment centre (shelves lined with bags of marshmallows), WIRED watches as a Freight robot follows one of Wise's co-workers down the aisle. A computer screen shows the robot's-eye view. The worker is represented by a pair of shuffling marks – think of the curve of someone's back heel – and Freight is programmed to recognise a typical human gait pattern. If someone were to step between the robot and the employee, as Wise does, there is nothing to stop Freight from simply following the closest set of feet. "It doesn't really matter," Wise says, "because you wouldn't be trying to steal someone's robot." This is one advantage Freight has over Savioke's Relay. "There's people, but it's a more controlled environment," Wise says. "They're getting paid to be there and not mess with the robot."



'One of the first things you have to ask about the hardware is will it accidentally kill someone?'

A Fetch robot, outside Fetch Robotics' headquarters in San Jose, California



Right: Melonee Wise, CEO of Fetch Robotics
Left: Adrian Canoso, co-founder of Savioke, which makes the Relay delivery robot



Fetch's activities are driven by this simplest representation of human feet. The device doesn't know who it is following (which could easily be done by scanning an RFID, a person's physical profile or even gait). Its external view of the world would be similar to the Terminator's, with all kinds of ambient information pulsing in its peripheral vision. But Wise has already managed WIRED's expectations about this: we tend to assign robots more power than they are capable of. In the Crowne Plaza, when WIRED opens the door, the robot's top hatch opens to reveal the snack we had ordered. Has it recognised WIRED as human? "We see the door as a plane," Canoso says, "using our 3D cameras." It is merely responding to a shift of a few degrees in planar perspective.

Or take the not-so-simple question of the robot knowing where it is. Couldn't you simply 3D scan an entire warehouse and load it into the robot's software? "That's computationally wasteful," Wise says, briskly. "You want to use your power for avoiding people."

Off-the-shelf mapping algorithms, she notes, "would struggle with mapping this building, which is only 1,000m^2. We have to be able to map 47,000m^2." Fetch generates a map by having a human drive the robot

around with a joystick. “Having the robots exploring the environment on their own is a bad idea,” says Wise. “You don’t want them in the stairwell or the toilets.” The robot’s map is generated, essentially, by déjà vu. It knows where it is when it “scan matches” against some place it has been before.

This works so long as the map and warehouse match. During one robot demonstration, the Fetch team had mapped a warehouse, then taken a break for lunch, during which workers dismantled a wall. “Imagine you’ve walked down a street for your entire life,” Wise says, “and someone has bricked it off.” After a moment’s feeling of dislocation, you would probably turn around in confusion. Similarly, robots are programmed to simply return to the dock: “You don’t want robots making unilateral decisions.”

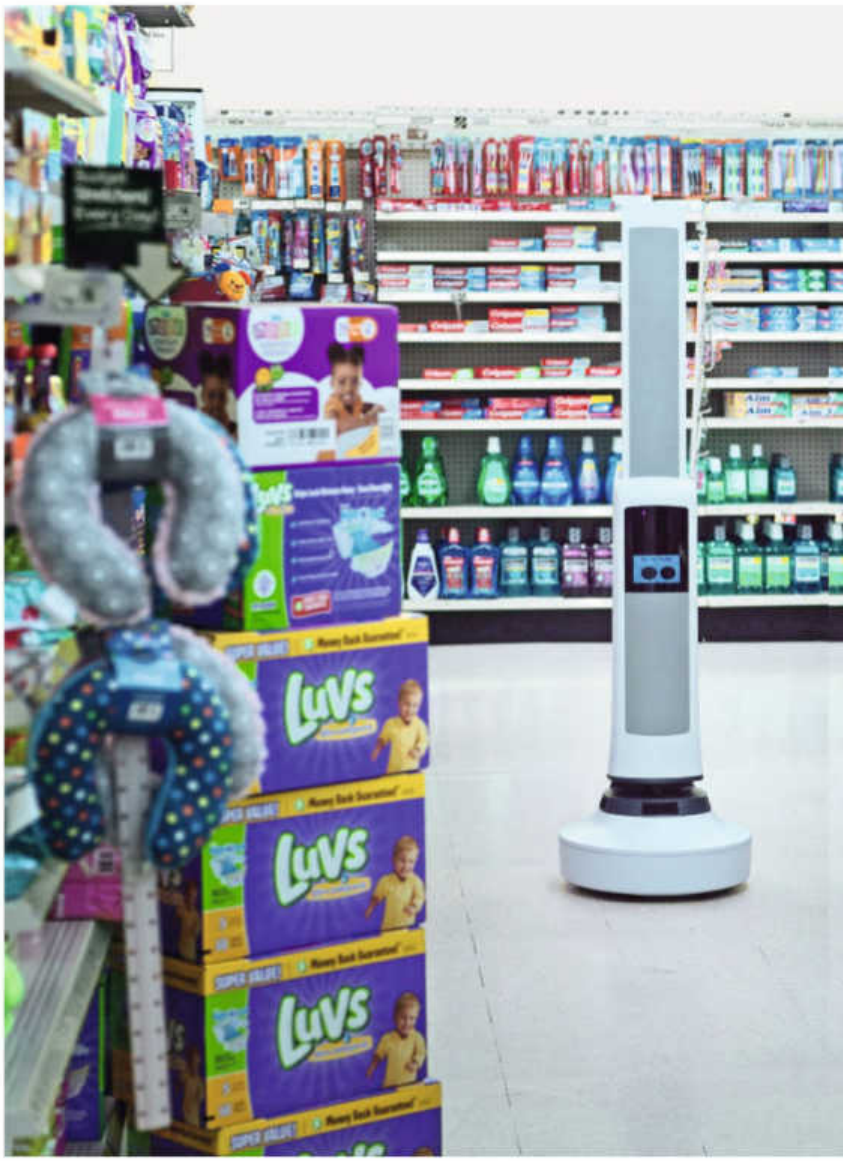
The trick is to reduce complexity. When the Fetch robot’s 3D cameras peer at the goods before it, it’s not trying to recognise a can of Coca-Cola out of every product in its database. Rather, it has been told to expect Coca-Cola in that section of the warehouse. “Warehouses know where things are. You don’t have to say, ‘I know this is a can of Coke,’ because Coke is supposed to be there,” says Wise. “Verification is easier than generic recognition.”

When Fetch looks at a shelf, she says, there are many things it does not see: the shelving itself, for instance, which is extraneous. “We determine everything that’s on a plane, and throw out all the info we don’t need.” Once you isolate the objects, Wise says, “grasp planning” – plotting the robot’s reach to pluck the item off the shelf – “is easy.”

When people ask how Wise is getting robots to pick the correct things off the shelf – a task so difficult, Amazon’s robotics wing has been hosting a yearly “picking challenge”, in which teams compete to get robots to correctly choose, say, a bag of M&Ms from a collection of objects – she says they tell her, “It’s impossible, you can’t recognise everything.” Her response: “We don’t try to recognise *anything*.”

‘Having the robots exploring the environment on their own is a bad idea. You don’t want them in the stairwell or the toilets’

The Tally robot compares the real world to a planogram of how a store should be laid out

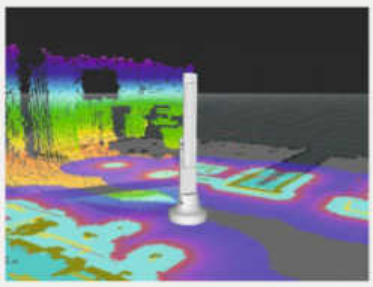


ROBOTICISTS OFTEN REFERENCE the Americans With Disabilities Act of 1990, a landmark piece of US legislation that resulted in massive changes in the landscape to accommodate people with disabilities. Because the majority of workplaces were required to install ramps, for instance, robots subsequently did not generally have to deal with differences in elevation. And so we had unintentionally paved the way for wheeled robots. A few years ago, British designer Matt Jones, now with Google Research in New York, referred to the “robot readable world”. “Instead of designing computers and robots that relate to what we can see,” he posited, “we meet them halfway – covering our environment with markers, codes, and radio-frequency identification.”

Perhaps his notion was incomplete: robots are increasingly able to move around in our environments as they are, without special markings or codes, in part because of technological improvements, but also because we had already been designing environments meant to compensate for human limitations. When Volvo launches an autonomous car project in Gothenburg, Sweden, in 2017 – the largest such trial to date involving everyday drivers – it will happen only in a section of the city’s ring roads with the clearest markings.

Human and robot interaction can have unforeseen consequences. Robots that are able to perfectly interpret our environment can cause problems for us. Clamman mentions the large autonomous trucks the Australian mining giant Rio Tinto uses to haul ore. The





Tally's 3D vision can sweep entire shelving racks to build a picture of the store

routes they were plying each day were so precise, he says, they were creating deep ruts that human drivers struggled to navigate. And so a bit of randomness had to be added to keep the dirt road level.

At Fetch, Wise says that grasping objects is relatively easy for robots, but they still struggle with vision – distinguishing a can of Coca-Cola from Pepsi. "We can do 2D recognition well, because it's a well-lit object in the centre of the frame. Now go into a factory, where it's dark and boxes are turned around wrapped in cellophane." Besides, Coke and Pepsi cans are usually kept apart to make it easier for human stock pickers. "So if it's going to confuse a human, it's definitely going to confuse a robot."

This idea comes into sharp relief as WIRED meets Brad Bogolea and Jeff Gee, the CEO and chief product designer of Simbe (for "simulated being") in San Mateo. Like Fetch and Savioke, the company was spawned by the legendary robotics incubator Willow Garage. Simbe's device, called Tally, is on trial with a number of retailers of "fast-moving consumer goods," as the category is called (think a chain of pharmacies). What Tally does – faster and more accurately than humans, says the company – is sweep up and down the aisles of those stores, unblinkingly casting its 13-megapixel 3D vision, comparing what is on the shelf against what should be there.

What retailers call "shrink", says Bogolea, represents a huge financial drain. "Retailers have a lot of supply-chain intelligence," he says. "They know what products come off the truck, and they know what products go out as they're scanned in customer's baskets." But in that hazy in-between, products can get stolen, sloppily arranged, or just lost (a store may have upwards of 180,000 stock-keeping units).

But how does the robot know what those shelves should hold? Large retail environments are typically structured according to "planograms", or visual blueprints of how each shelf should look, created to ensure standardisation across stores. "The planogram is the ideal state of the store," Bogolea says, "and we're capturing the real state of the store." From there, it is essentially a matter of pattern matching (made easier, says Bogolea, by the fact that consumer goods producers strive for visual differences in their packaging).

Tally, other than needing, as Bogolea puts it, "power and a place to live", requires no other changes to the store environment. The planogram, a tool to make humans more efficient – more like robots – is already optimised for machine intelligence. The robot-readable world was already here. W

Tom Vanderbilt wrote about The Echo Nest in 02.14

THREE MORE

ROBOTS THAT ARE INVADING THE HUMAN WORLD



Developed by the co-founders of Skype, **Starship Technologies**' 99 per cent autonomous robots can deliver packages, dodge obstacles and cross roads. They will be tested on London's streets this year. *starship.xyz*



Aldebaran Robotics and SoftBank Mobile's **Pepper** interacts with humans by analysing facial expressions, voice tone and body language. Peppers greet customers in more than 140 Japanese SoftBank stores. *aldebaran.com*



Prospero is a six-legged farming robot that can patrol an acre of land, detect a patch of unplanted soil, plant a seed and cover it with fertiliser. Inventor David Dorhout intends his robots to work in a swarm. *dorhoutrd.com*
Pauline Bock

OVERHEARD AT WIRED THIS MONTH

"Can we all just go to our desks and Google 'artisanal ice-cream'?"
"I'm going to call for an immediate moratorium on people wearing VR goggles. And on drones. It's enough to make you long for the good old days of photos of laptops."

Please pitch stories to editorial @wired.co.uk
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EGO INFLATION THIS MONTH

WIRED's creative director had an encounter with a BIG celebrity at the littleBits office: "During the shoot, I came across the incredible Insta-Ego Head. Built by littleBits product designer David Sharp, it monitors *Instagram* for #littleBits mentions – when it detects one, the balloon gets a shot of air and Kanye swells up. I think he must have tripled in size while I was there. It's exactly the kind of fun, inventive thinking you find everywhere at littleBits."
Want to make your own? Get the instructions from littlebits.cc/projects/insta-ego-head

ALSO OVERHEARD AT WIRED THIS MONTH

"There's nothing quite like crushing a young person's soul before lunchtime" – the aftermath of explaining why we are hyphenating "co-living".
"I was booked to stay at the Ace Hotel, but it was too loud and rock 'n' roll" – creative director on his return from a New York photoshoot.
"Touch it. It's SO pleasing. Yes, touch it..." - not what you're thinking, but the arrival of the new Impossible Project camera in the WIRED office.
"What I need is for you to immerse yourself in the worst PowerPoint presentation ever" – editor's advice on designing our celebration of the infamous program.
"You've taken it to a very dark place. I wasn't sure just how bad we could make this" – the creative director's reaction.
"I'm very sparing with my Likes, but I'll always Like your things. I can't quit Liking you" – inter-department *Instagram* love.
"This guy doesn't quite look real. I don't think I'd want him to be my robot."

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Visit **www.erroyl.com** to order from their online boutique.

Essential Dark Hours Watch by Greyhours

Greyhours is a new brand creating ambitious watches by taking advantage of exclusive materials commonly used for the manufacture of high-end timepieces.



The 9.10mm thick Essential Black DLC featured here is their first model, £150.

Visit **www.greyhours.com** or email **sales@greyhours.com** for further information.

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MP, the hot new brand in swimming, is an exciting collaboration between Olympic legend **Michael Phelps** and goggle guru Aqua Sphere. Worn by Phelps, the uber cool MP XCEED goggle delivers wide peripheral sight and superb comfort. SRPs from £24.99
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The current **Urban Jürgensen** Collection reflects the brand's devotion to Honouring Timeless Traditions in handcrafted elegant timepieces. Their aura of restrained excellence means their watches are appreciated by Collectors and Connoisseurs worldwide. The stunning new collection includes 5 new watches. Seamlessly blending an application of pure hand craft and style, they display all visual landmarks of distinction that can only be found in Urban Jürgensen timepieces, and are perfect for anyone who seeks the very finest things in life!

Call **+41323651526** or visit **www.urbanjurgensen.com**



THE WIRED INDEX

19,612

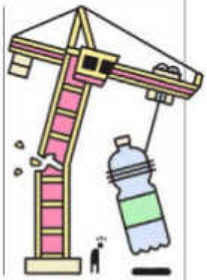
Number of named characters appearing in the *Star Wars* expanded universe, according to data scientist Kirell Benzi

48m

Number of paywalled scientific papers made freely available by Russia-based "research pirate" website Sci-Hub

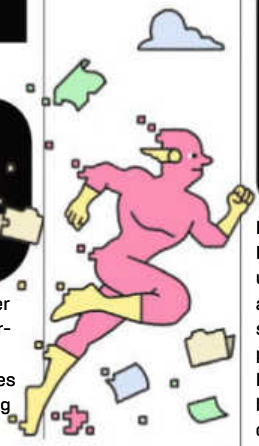
5 BILLION TONNES

The amount of long-lasting plastic produced by humankind until 2015, estimated by geologists at the University of Leicester in a study published in scientific journal *Anthropocene*



1,125

The fastest data transfer rate ever, in terabytes per second. Achieved with enhanced fibre-optic super-transmitters built by a team at University College London, who transmitted random binary sequences between two machines. At this speed, downloading all of *Game of Thrones* in HD would take a second



0%

Percentage of Icelandic citizens under 25, from a sample of 821 surveyed by polling agency Maskína, who believe that God created the world

2

Estimated years before Adobe's Flash Player becomes obsolete. The video codec made up only six per cent of mobile and web video in 2015

11.5%

Percentage of Syrian population killed (470,000) or injured (1.9m) since the start of the current crisis in March 2011, according to the Syrian Centre for Policy Research

21

The number of different "wolf dialects" discovered by a team of Cambridge zoologists, who listened to over 2,000 wolf howls and classified them depending on pitch, volume and modulation

22,338,618

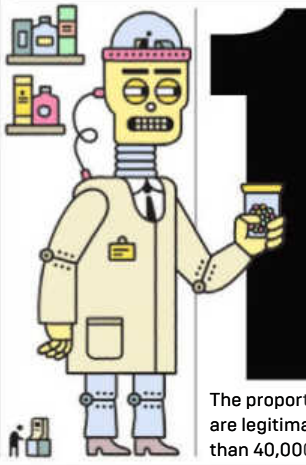
Number of digits of a prime number discovered in January by a voluntary researcher working at the Great Internet Mersenne Prime Search, an online prime-hunting collaborative project

260,000

The number of robots currently in use in US factories, which is the highest ever, representing a 14 per cent jump since 2014

$0.53

The average yearly revenue per paid user of Match Group, the company owning dating properties Match.com, *Tinder* and OkCupid, in 2015. Down 14% from 2014

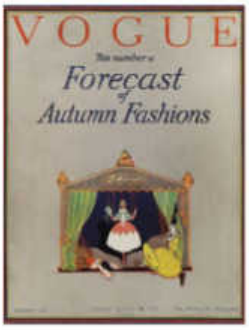


1%

The proportion of online US "pharmacies" that are legitimate – only 400 out of more than 40,000 – according to legiscript.com

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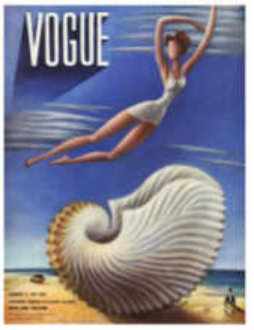
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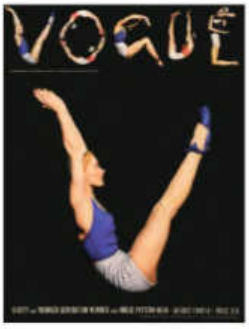








































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OYSTER PERPETUAL 39

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Laundry care has reached a new level of excellence. Loaded with innovation, Siemens avantgarde appliances are perfectly designed for modern living.

Intuitive multiTouch LED displays and inclined control panels keep functionality effortlessly simple. Meanwhile, ground-breaking iSensoric technology uses intelligent sensors to automatically manage your entire washing or drying process.

Add to that our automated self-dosing system, i-Dos, and it's easy to see how the new Siemens avantgarde laundry range will add a touch of brilliance to your home. For a life less ordinary.



Laundry care just got a touch smarter.

The new Siemens avantgarde appliance range is awash with intelligent features, from iSensoric and i-Dos technology to state-of-the-art, intuitive multiTouch LED displays.

siemens-home.co.uk/avantgarde

Siemens. The future moving in.

SIEMENS



Do clothes have to deteriorate with laundering? Not on our wash.

Siemens iSensoric appliances use sensor technology to perfectly clean your clothes with the utmost intelligence and care.

siemens-home.co.uk/laundry-care

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Serving one simple purpose; to keep your clothes looking and feeling amazing for many washes to come. For a life less ordinary.

Siemens. The future moving in.

ON THE COVER
BURBERRY NUDE LASER-CUT LACE LAMBSKIN TRENCH COAT

This trench has more than 70 components and is an adaptation of the brand's Heritage range in a Kensington tailored fit. The distinctive lace pattern was cut into the coat using a laser. After bonding two nappa skins together, the pattern pieces are enlarged to allow for shrinkage during the computer-controlled process. The double-breasted 95cm design, however, with epaulettes, hook-and-eye collar closure, gun flap, belted cuffs and storm shield, remains faithful to classic Burberry trenches.
£3,995 uk.burberry.com

THIS PAGE
MOS LABS 3D SUIT

Based in the US, Ministry of Supply has created a suit that is as comfortable as "sweats" (or a tracksuit, in the Queen's English). The traditional wool has been substituted for a super-light foam-like polyester that is moulded around the human form. This soft-yet-structured suit also offers insulation in the colder months, is machine washable and wrinkle-proof, and wicks moisture. Underneath is the MOS Mercury sweater, which has a seamless ventilation pattern that opens as you move, allowing air to flow through. To complete the assault on sweat, the merino/acrylic fabric is bonded with carbonised coffee-infused nylon to eliminate unwanted odours.
Jacket $450; trousers $250; sweater $165 ministryofsupply.com



The sponge-like material and shaped cut means this suit can almost hold its form without an occupant

CONTENTS

04 **THE FAST TRACK**
12 **TESTED: HEART RATE TRACKERS**
14 **FUTURE FASHION**
18 **FABRIC**
24 **VIRTUAL RUNWAY**
27 **TESTED: VR HEADSETS**
28 **LIGHTER, FASTER, SMARTER**
30 **TESTED: SWIM TECH**
32 **THE FITNESS INDEX**

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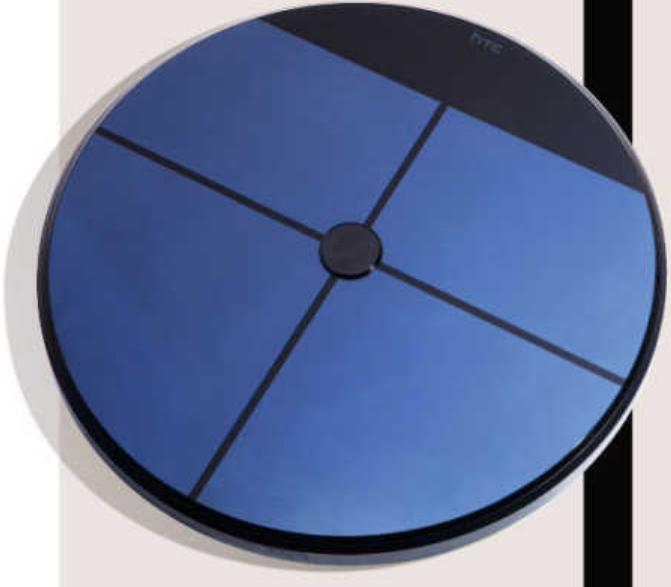


PHOTOGRAPHY: JOSH VALCAREL & BEN SKLAR

THE FAST TRACK



BY DAVID PIERCE



The UA HealthBox kit is the firm's latest step in the race to become a tech company

UNDER ARMOUR ISN'T A CLOTHING FIRM. IT'S REALLY A TECH COMPANY

Sports-clothing company Under Armour was founded on a simple idea: make athletes better. To do that, it's turning human performance into a big-data problem. The Baltimore-based company is betting on the notion that the right hardware, the biggest data set, a lot of machine learning and powerful motivational tools can make everyone better, faster, and stronger. It's betting that technology doesn't exist solely to bring everything to our door with the push of a button.

The centrepiece of that bet is its $400 (£282) kit announced in January. Called UA HealthBox, it provides scales, an activity-tracking wristband and a heart rate measuring chest strap (*left*). The company is also updating *UA Record*, its mobile health and fitness app, making it a 24/7 real-time barometer of your fitness and health. These tools, combined with three apps Under Armour has purchased in recent years, provide the most comprehensive ecosystem of fitness products yet.

This represents a huge investment for the company, which started 20 years ago in a basement in Washington, DC. It has spent more than $700 million since 2013 in a bid to correct a fundamental flaw in every activity tracker and app: none of them communicate with each other. Apps don't sync with other apps or most hardware. And switching from one device to another means starting from scratch. There are too many walled gardens and most of these apps and gadgets do a lousy job telling you what to do with all this information.

Under Armour is taking a comprehensive approach where everyone else is piecemeal. It worked with HTC on the hardware scales, wristband and heart rate monitor. It also worked with Harmon Kardon on a pair of Bluetooth heart rate-tracking headphones. And it all connects effortlessly to the *UA Record* app.

It's all very slick – but that's not the point. Someone will almost certainly one day make hardware that's cooler and smaller. Under Armour CEO and founder Kevin Plank doesn't mind. In fact, he welcomes it. He's committed to supporting anything anyone wants to make for *UA Record*.

All he wants is your data. After all, it's all every tech company wants. And make no mistake: Under Armour is a tech company. That's where this entire industry is heading. The days of wristbands and straps are numbered. Soon, our fitness trackers will be built into our shoes, our shirts, our headphones. Everything will be a fitness tracker, and every fitness company will be a tech company.

This is the idea that drives Plank. He doesn't care what his designers and engineers and product people do when adidas or Nike makes a cool new shoe, or how they'll compete with the next Fitbit. He's thinking bigger than that, and he's prepared to fend off all comers. "What are we going to do if – when – Apple makes a shoe?" he asks. "We're contemplating right now: 'How do we make it before they do?'"

THE ORIGINAL WEARABLES

The Under Armour story is a lot like a Tom Hanks movie: an all-American kind of guy joins a college football team and becomes its beloved captain. He hates how sweaty his workout shirt always is, decides to make something better, and develops it in grandma's basement. His company grows and grows, eventually signs deals with basketball hero Stephen Curry and quarterback Tom Brady, and outfits everyone from the Notre Dame American football team to Marvel superhero wannabes. He earns billions making the world a better place where everyone looks cool and every drop of sweat is wicked. Roll credits.

Under Armour is growing like mad, and has been for years, but remains well behind market leaders Nike and adidas. "It's going to take five, ten, 20 years before they're ahead of Nike," says Adam Thorwart, a senior research associate at Strategy Analytics. It's hard to out-swoosh the swoosh, after all. Plank hates being in third. He won't even say Nike's name, referring to the company only as "our competitor". He's got no more love for adidas, which on TV he once called "our dumbest competitor."

And so you can imagine that Plank is determined – you might even say obsessed – with shortening that takeover timeline. He knows his best shot at it is to stay ahead of the curve. After all, even though everyone makes a compression shirt these days, Under Armour dominates the category. "I think first-mover advantage is a very powerful thing," he says. Of course, being the first mover means knowing your next move.

Plank's been planning his next move for some time.

He telegraphed it back in 2009, when hundreds of college football players descended on Lucas Oil Stadium in Indianapolis for the NFL Combine. Quarterback Cam Newton and wide receiver Julio Jones were two of the hottest players on the field, and everyone was watching them. They were decked out in skin-tight red tank tops with a yellow ... thing in the middle. It looked like a big round bug with an Under Armour logo.

That thing was the E39, a workout shirt with a removable biometric sensor which measured just about everything they did on the field. When Jones ran, his shirt tracked his heart rate, acceleration and power. When Newton jumped, it measured the g-forces and power in his vertical. Under Armour believed players could use the data to train better and scouts could use it to make smarter decisions. No one had seen anything quite like it.

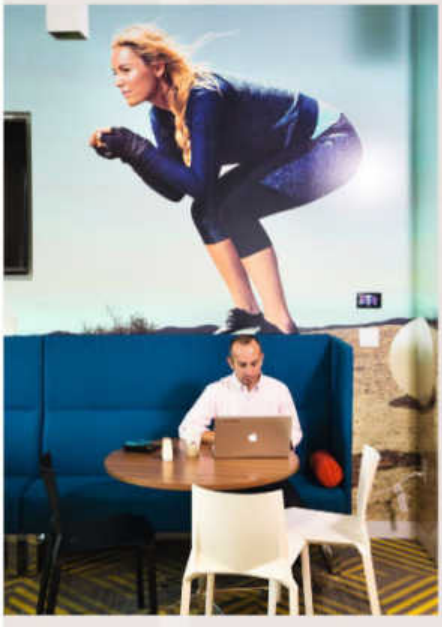
The idea started with a conversation four or five years earlier, when Plank grabbed a 0039, the compression shirt he'd created in his grandmother's basement, the one that launched the Under Armour empire, and handed it to Kip Fulks, then EVP of global product at the company. Make it electric, he said, not really knowing what that meant. "I just said, 'Make it electric,'" Plank says. The project didn't pan out. Oh sure, it was cool as hell, and it worked. But it was so complicated and expensive it wasn't the slightest bit feasible.

Yet it would go on to change everything at Under Armour.

ALL YOUR CLOTHING WILL BE CONNECTED

Plank made his next move in November 2013, when Under Armour execs visited MapMyFitness to talk about an acquisition. It was a first for Under Armour, but Plank needed a tech team, fast. MapMyFitness had maybe 20 engineers. But Plank also needed a leader, which he saw in MapMyFitness CEO and co-founder Robin Thurston. Plank knew Thurston's crew was up to the task – he used its *MapMyRun* app every time he ran.

During his presentation, Plank played a 60-second ad called "Future Girl". In it, a young woman wakes up in an austere apartment and walks to her dresser. She removes an Under Armour garment, one of an identical dozen, each neatly folded. The time, the weather and the day's schedule appear in a projection before her. She dons the magical glittering fabric, which conforms perfectly to her body. As she does yoga, following prompts projected on her window, her vital signs appear on her sleeve. Later, with two taps, her outfit changes colour and transforms from a full-body leotard into a stylish running outfit. It's effortless, automatic, and oh so futuristic. "All you must provide," a voiceover says over soothing beats, "is the will to make it happen".



Right: MapMyFitness CEO, Robin Thurston
Above: Under Armour's offices in Austin, Texas

"Future Girl" is Plank's opus. He's been crafting the concept for a decade. He directed every shot of the video, which took forever because there was no budget for an ad for a product that doesn't exist. "I made this for you," he told Thurston privately. "I need you to come help me build this."

Almost two years later, Thurston is sitting in his large office at the company's Connected Fitness headquarters in Austin, Texas. Like everyone else, he's decked out in Under Armour. His office, down the hall from the in-office gym, where a dozen staffers forgo their lunch break for a trainer-led boot camp, is full of Under Armour marketing material. A pro cyclist, Under Armour's chief digital officer is still trim and athletic, his age (43) betrayed only by the flecks of grey in his close-cropped hair.

When he first saw "Future Girl", Thurston didn't think much of it, or the idea. He saw an advanced Garmin device. Now he sees something different. "She has a personalised yoga experience that morning," he says, "maybe because her heart rate was too high when she woke up, so she was stressed." Her meal plan is specific to her day, her mood, her context. So is her run. So is her clothing. Her universe is collecting, processing and collating data constantly, feeding it back to her so she might live a little better each day. This, he says, is the future. "Every piece of clothing you wear is going to be connected, and someone's going to have to decipher that data and give that back in an organised way, for you as an individual, to help you in your life."

After acquiring MapMyFitness in 2013, then Endomondo and MyFitnessPal in 2015, Under Armour has some 150 million users, and claims more than 100,000 are joining every day. All those people have logged more than 1.7 billion workouts last year alone. That's a lot of data. Plank's challenge is figuring out what to do with it all. How can he use it to make you a better person. "How does [tracking] translate into me feeling better?" Plank says. "Feeling better about myself, feeling better about how I look, how my jeans button."

Figuring that out means designing a complete fitness tracking system, one that understands you. It's such a logical idea that Plank still can't believe no one beat him to it.

HIT RECORD

Plank likes to take credit for coining the term "connected fitness", even if Under Armour was late to the party. *Nike+* has been feeding data to runners for a decade; *Runkeeper*, *Strava* and others are trying to be visible where data-driven athletes hang out. Fitbit has a whole tracking ecosystem. Even the Apple Watch's is an activity tracker. At this point, anyone who really wants a fitness tracker probably has one.

Under Armour had to offer something more. That's where *UA Record* comes in. It's a dashboard for all the data Under Armour can collect about your exercise, activity, sleep and nutrition. Below the numbers is a simple question: on a scale of one to ten, how do you feel? All five parts are important, but it's the connections between them that really matter.

Plank's long-term vision for *UA Record* goes something like this: it knows your location, and the day's forecast there. It knows you run best when it's between 15°C and 21°C, and when it'll be that temperature. It will alert you to that, and tell you when it's time to go. It will know there's a gym around the corner, that's offering a class you love, and will sign you up and check you in with a single swipe. Visit the doctor and you'll have all the data needed to take charge of your own health. "It's this concierge where we're doing every single thing for you except the workout," says Chris Glode, Under Armour's vice president of digital. "Which is the hardest part."

UA Record doesn't do all of this. Everyone at Under Armour knows it. But they're sitting on an unprecedented data set about people's health and fitness, and the odds are that everyone who buys a fitness-tracking product will download at least one Under Armour app. Now the company must figure out what to do with all that data – and how to use it to sell people more gear. No matter how big the Under Armour app platform gets, it always comes back to the company's mantra, written in big red letters on a whiteboard in Plank's office: *don't forget to sell shirts and shoes*.

As our gear becomes more connected, more malleable, more personalised, selling shirts and shoes will become precisely the point. Everyone's going to want to make them, but Under Armour's not worried. It's been making shoes for a while.



SHIRTS AND SHOES

In February, Under Armour launched a version of the SpeedForm Gemini 2, its most popular running shoe, with a chip in the heel that contains an accelerometer, a Bluetooth antenna and a battery. When Paul Pugh, Under Armour's VP of connected fitness products, lays the red and grey shoes on the table, the first thing he does is yank off a tag with the shoes' MAC address. "We wanted to see what it means to just manufacture a sensor right into the shoe," he says. They had to re-tool some of their factories – making shoes and making sensors are very different things – and overhaul some of their testing and quality-control processes. But other than the unique colouring, this Gemini looks, feels and runs just like any other.

When you put on the Geminis, they start tracking your steps. Run faster than a seven-minute mile and they collect even more data. Since Under Armour knows your shoe size and height, the shoes can measure your pace and analyse your stride. The shoes can track their own wear and tear and let you know when it's time to replace them. There is a lot more that's possible, but Under Armour's moving slowly. "I think the first phase of the sensors is making it easier to capture data," Pugh says. "Whenever the athlete's moving, there's data being generated, and most of it's being lost."

That's the idea behind the shoe, behind the first phase of UA's whole HealthBox and *Record* strategy: collect data. More data. Better data. Any data, really. "We don't even really know how to use it yet," Pugh says, "but the goal is, let's collect the data, let's improve the quality of it."

These are all just baby steps. Under Armour is trying to learn how this stuff works, to see what it looks like when a company tries to do the whole thing. Ten years from now, Thurston says everyone will call Under Armour a tech company. It'll seem obvious.

FITTER by DESIGN

Is Under Armour's HealthBox the ultimate one-stop health and fitness package?

WIRED got exclusive early access to HealthBox, Under Armour's wearable health ecosystem. Made in conjunction with HTC, the all-in-one kit monitors activity, sleep, fitness and nutrition using a mixture of the UA Band fitness tracker, chest-strap heart rate monitor, scales and the *UA Record* app. The system was tested for ease of use, practicality and usefulness of data. Chris Haslam

ON THE WRIST: UA BAND

This covers all the tracking essentials: resting heart rate, fitness, step counting, sleep analytics, alert, alarms, phone notifications and music control, all accessed through the touch display. It can be synced with the UA Heart Rate chest strap for instant feedback, but the blurry OLED display and tiny font are near-impossible to read while running. **5/10**

UNDER THE FEET: UA SCALE

The Scale records weight and body-fat percentages, which it uploads to the app. Compared to the Fitbit Aria scales, measurements were accurate, and if you've set a weight goal you'll get on-screen feedback. However, the scales frequently failed to recognise WIRED's profile and occasionally uploaded completely erroneous data. **6/10**

ON THE CHEST: UA HEART RATE

Designed for high-intensity workouts where data accuracy is key, the Bluetooth heart rate strap syncs either with *UA Record* or the UA Band – but not both at once. A tiny LED on the UA Band changes colour with heart rate shifts, but there's little motivational help during a workout – odd given the superb voice coaching used by Under Armour's own *MapMyRun*. **7/10**

IN THE HAND: UA RECORD APP

The app is fresh, engaging – and deserving of better hardware. It's easy to set goals and view your progress, but to get the best from the Nutrition tracking you'll need to subscribe to *MyFitnessPal* (a year's membership is included). It also lacks any form of coaching, but the Challenges tab lets you compete with millions of other *UA Record* users. **8/10**

WIRED'S VERDICT

UA's all-in-one setup is a great idea, but it's not a seamless experience. The *UA Record* app is superb – and it works with Fitbit, Withings, Garmin and Polar gear. Until UA's hardware improves, you're better off creating your own fitness-tracking ecosystem with vastly superior devices, and running the show with Under Armour's impressive software. **6/10** *$400 underarmour.co.uk*

CLOTHES THAT CONNECT

The line that divides clothing and technology isn't blurring, it's disappearing – as proven by London-based fashion house CuteCircuit

Photography: Max Oppenheim

A shirt that sends your friends virtual hugs. A handbag that displays tweets and messages. A dress that sparkles like the night sky. Today, the term "wearable" covers more than smartwatches and VR goggles.

"We try to make experiences that make you feel empowered, and help people connect with one another in a way that is intimate or fun," says Francesca Rosella, creative director of CuteCircuit – a design house that's been producing fashion embedded with technology since 2004.

Co-founded by Rosella and Ryan Gentz, the outfit's first design was the Hug Shirt, which senses touch and can send – or receive – a squeeze and targeted warmth to someone also wearing the shirt.

Originally producing concepts and catwalk pieces, Gentz and Rosella are now creating a line of ready-to-wear fashion.

"We're trying to change the way people consume 'disposable' fashion," says Rosella. "We want our designs to last a really long time, so we use really nice luxury materials such as silk, and then we embed the micro-LEDs that we call magic fabric."

CuteCircuit's clothes are ruthlessly tested to ensure they can survive in a typical washing machine at 30°C. But Rosella is excited about new devices that might be more delicate, such as articles containing gold electro-conductive ribbon, LEDs, and reflective material.

"There is this amazing new Siemens [sensoFresh] washing machine that can refresh garments without detergent and water," she says. "It's like an appliance from the future – you put clothes in, it refreshes them with a very futuristic looking mist and they come out dry and smell perfect."

cutecircuit.com

WHITE DRESS WITH BLUE FRINGING

Designed to combat unwanted paparazzi bombardment, this ultra-reflective dress creates a mesmerising effect when hit by flash photography.

Perforated, heat-bonded, and laser-cut microfibre embedded with reflective micro-beads

Not only will the dress dazzle any potential photographers using a flash, it will illuminate on the dancefloor by reflecting any sources of light.

Glass micro-spheres



Unveiled during New York Fashion Week in CuteCircuit's Spring/Summer 2016 collection, the outfit can be washed at 30°C. For added peace of mind, using Siemens' sensoFresh refresh program will gently remove odours in 30 or 45 minutes, depending on the required intensity without using water or detergent.

~650g



IVORY PLEATED SKIRT AND BOX JACKET

The colour or design of this outfit can be controlled using an app. It is able to display live tweets, animations or illuminated patterns.

CuteCircuit conductive "magic fabric"; multiple environmental sensors

The pattern on this outfit is controlled by smartphone. Siemens' new avantgarde washing machine and tumble dryer can also be controlled using touchcreen – a large LED display on the machines' fascia. Other Siemens laundry appliances are also Wi-Fi ready, enabling them to be controlled and monitored using the Home Connect app.

~500g

This dress carries the DNA of a full-length light-up dress CuteCircuit created for singer Katie Perry, when she appeared at New York's MET Costume Institute Gala in 2010.

3D woven ivory silk and black silk satin



SILVER METALLIC PARKA AND UV PROTECTIVE RED SWIMSUIT

This ultra-thin and lightweight parka is coated with metallic molecules that make it very warm. The swimsuit is made out of UV-protective material to protect from strong sunlight.

Metal-coated ripstop nylon; anti-UV microfiber

This swimsuit protects the wearer's skin against Sun damage. Siemens' iSensoric machines protect your clothes by sensing every aspect of the wash – from the materials in the drum, to the temperature and the load weight. This will automatically adjust the length of the cycle, temperature and appropriate detergent dose accordingly.

Parka: 150g
Swimsuit: 270g

TESTED HEART RATE TRACKERS

HEART RATE TECH EXPLAINED

OPTICAL HEART RATE (OHR)
LEDs are shone through the skin in a technique called photoplethysmography. An OHR sensor examines the density of each LED pulse that bounces back and translates it into heart rate.

CHEST STRAPS (ECG)
Monitors such as the MZ-3 (*below right*) emulate medical electrocardiogram machines by measuring electrical pulses. Their proximity to the heart ensures the most accuracy.

IN-EAR OPTOMECHANICAL
These work by shining light against the skin inside the ear to detect blood flow and oxygen consumption. Your ears are packed with small blood vessels, meaning more accurate readings.

POLAR A360

FITNESS TRACKER
The A360 is Polar's first device to use a built-in optical heart rate sensor to track activities ranging from running to strength training, but it failed to impress Susie Chan. "I'm not convinced about the design," she says. "I have small wrists and, because the watch face is only held in place by the rubber wristband, it occasionally fell out while I was putting it on. I also wonder how this would age with a little wear and tear." The tracker's colour touchscreen display puts your well-presented heart rate stats where they're easy to see during sessions, but the app proved frustratingly unreliable. "The stats you see on the display are refreshingly simple, but the band just refuses to sync with the *Polar Flow* app. So although there are lots of additional rich features, they're no use if you can't get your data to upload consistently." **5/10** *£154 watchshop.com*
Battery life **Two weeks**
Weight **31.7g - 37.3g**
Wireless app sync **Yes**



JABRA SPORT PULSE

WIRELESS HEADPHONES
The Sport Pulse (*right*) has two big selling points: listening to music while working out helps you work harder; and our ears are a more accurate place to stick a heart rate sensor than a wrist (*see panel, left*). "I tend to have a problem with earphones but these sat really well," says Chan "They were the easiest to set up and the real-time updates were really motivational." The only drawback? "You have to wear them at all times to track heart rate. I sometimes like to train with friends and headphones aren't the most sociable. It's also a real shame they don't link up with third-party communities such as *Strava*." **8/10** *£199 jabra.co.uk*
Battery life **4.5 hours**
Weight **16g**
Wireless app sync **Yes**

HOW WE TESTED
With the help of record-breaking ultramarathon runner Susie Chan (*below*), WIRED tested three heart rate tracking devices. Each aims to use data to help you train more efficiently. Chan wore the trackers for a long run and a cross-training gym session, assessing comfort, usefulness of the real-time training feedback and the post-workout features of the partner apps.



SUSIE CHAN'S WORLD RECORD TREADMILL RUN:
Time **12 hours**
Distance covered **110.2km**
Calories burned **5,831**
Water drunk **Six litres**
Snacks **Two slices of pizza, five bananas, two doughnuts. Lots of Coca-Cola, two cups of tea**

MYZONE MZ-3

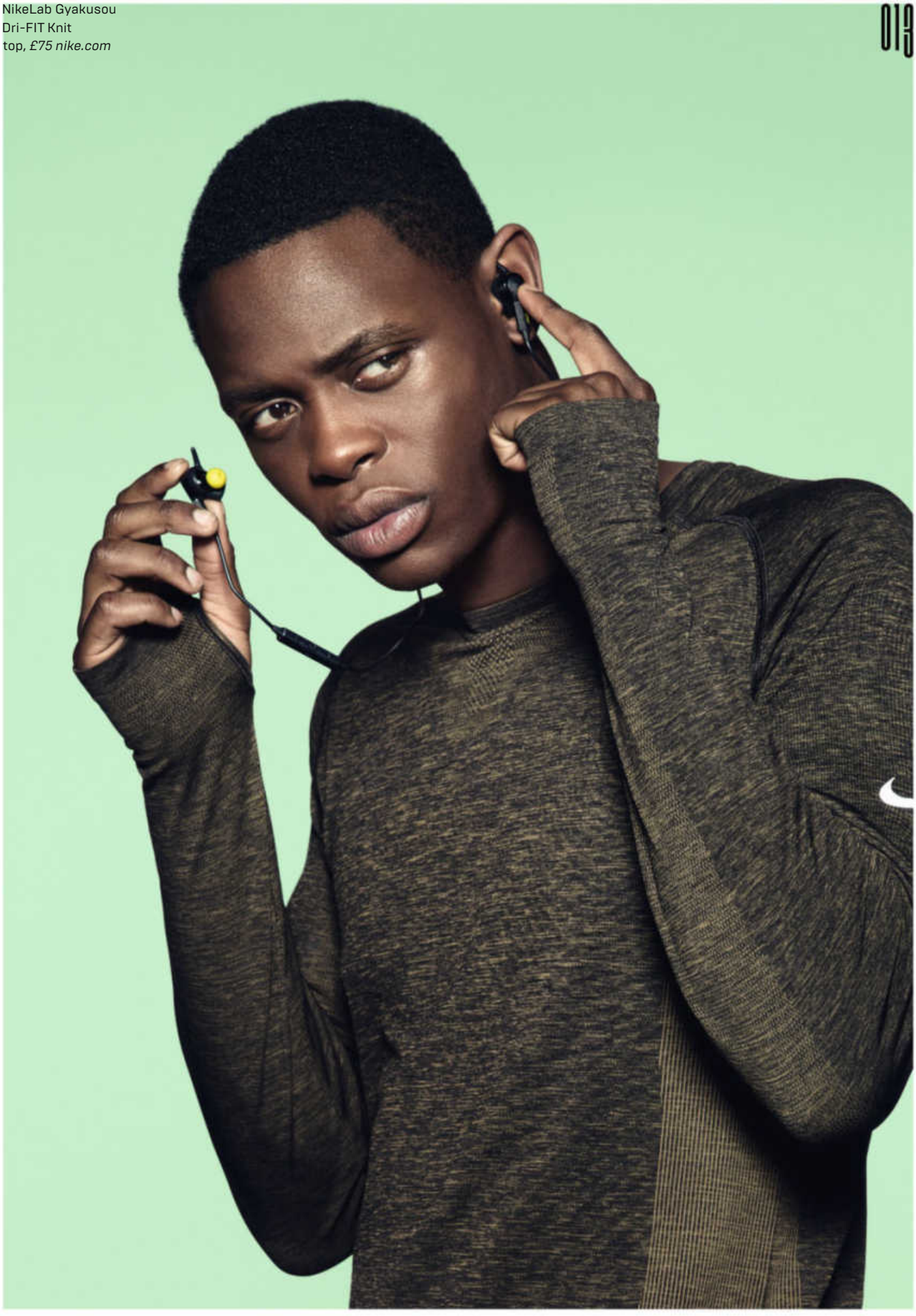
PHYSICAL ACTIVITY BELT
The MZ-3 puts a clever spin on fitness. It turns training into a social experience, converting your heart rate performance into points (MEPs) that reward effort rather than speed, distance or your base fitness. This way you can compete with people of all abilities on a level playing field. "I love how easy this is to use," says Chan. "It's comfortable and takes virtually no time at all to set up. The app is very intuitive and includes all of the things I'd expect to see, along with a great set of extras such as a food log and sharing stats into *Strava*. The social aspect really helps with motivation, too." There is one drawback, however: "Unless you own a compatible smartwatch, you can't see your current heart rate while running or working out without looking at your phone, and that's not ideal." **7/10** *£130 myzone.org*
Battery life **Seven months**
Weight **56g**
Wireless app sync **Yes**



The water-resistant MZ-3 claims to be 99.4 per cent as accurate as an ECG machine

WORDS: KIERAN ALGER. PHOTOGRAPHY: MAX OPPENHEIM

NikeLab Gyakusou
Dri-FIT Knit
top, *£75 nike.com*



The Jabra Sport Pulse earbuds are built to meet rain, shock, sand and dust standards for the US military



Above: Richard Nicoll's LED "Tinkerbell" dress, created by XO in collaboration with Disney

FUTURE FASHION

BY RACHEL ARTHUR

It's not unusual to hear of technology companies aligning with fashion brands: Apple teamed up with Hermès for the Apple Watch; Intel with Opening Ceremony for the MICA bracelet; and in New York Fashion Week, Fitbit announced an accessories collaboration with Public School for its new Alta fitness tracker.

Commonly referred to as wearables, what unites such products further is that they're all based on dressing up hardware. In fact, look across this landscape and the majority of releases to date are indeed devices, and not, though the word "wearable" should suggest otherwise, the softer side of fashion.

"It's 2016: where's our smart clothing?" asks Matthew Drinkwater, head of the Fashion Innovation Agency at the London College of Fashion. Many barriers have inhibited connected textiles and advanced material science hitting retail, he explains. "The challenges that the industry is facing in integrating electronics into clothing are so huge that it's been the slowest area of growth in wearable technology."

Health and fitness aside, fashion brands are still a long way from this world. Drinkwater highlights challenges ranging from manufacturing to power, as well as the problem of putting connected clothing in the washing machine.

One company trying to solve this is Google. Its Project Jacquard initiative in partnership with Levi Strauss & Co, due to launch later this year, will bring touch interactivity to a pair of jeans thanks to conductive yarn and an accompanying sensor.

Figuring out how to do that is one thing – achieving it at the sort of scale that Levi's reaches is another. Ivan Poupyrev, technical programme lead at Google's Advanced Technology and Products (ATAP) group, says the only solution was to make Jacquard yarns compatible with existing manufacturing techniques.

"The core of Jacquard is new yarns that can withstand the harsh realities of apparel manufacturing and keep superior electrical qualities," he explains. "Once you have this, the aim is to produce interactive textiles everywhere, in any size, colour and weight. That makes it easier for the apparel industry, because we can work with their preferred textile manufacturers, ones which are already certified, have a supply chain established and a history of relationships," he explains.

News is yet to follow on what exactly the resulting pairs of Levi's will be able to do, but earlier insights from Poupyrev hinted at turning lights on or off, activating our phones and even taking a selfie.

Although such functionality seems superfluous now, Billie Whitehouse, founder of tech company Wearable Experiments, suggests it's about removing the need to rely on phones. "We're seeing people taking time away from handsets. It has the potential to make what we're wearing all the more important."

She introduced the Fan Jersey ahead of February's Super Bowl in the US: a shirt that fans can wear to feel the reverberations of major plays on the football field. Connected via Bluetooth, the haptic vibrations occur in real time with the game, creating an emotional attachment for the wearer.

Others, such as Neurocouture, aren't creating feelings but rather monitoring them. Launched during the VFILES show at New York Fashion Week in February, its fabric is controlled by brainwaves – the patterns changing in response to emotions including love, anger and despair. This is something London-based science and design studio THEUNSEEN has also experimented with. It launched a sculptured jacket in partnership with Holition in 2015 that revealed emotions through colour by similarly reading EEG data.

Other functionality currently being explored for wearable technology is more practical, such as regulating body temperature to enable greater comfort or generating electrical charge merely by motion, so batteries are no longer required.

And this is just the beginning, according to Poupyrev: "The ability to weave blocks of computation suggests a future where not only sensor elements can be woven as we did in Jacquard, but complex computing, sensing and actuation devices." He imagines a range of garments that can sense the body's state and yarns that can change properties, such as hardness. "[They could] help the body in times of stress, exertion or injury. Clothing could know where it's broken and perhaps repair itself, or apparel could change visual appearance and colour, but also adjust density to let in or restrict airflow."

In designer Anouk Wipprecht's case, the aim is to ensure safety and protection. "My designs educate the wearer of potential stress factors around [their] bodies," she says. The Intel-Edison Spider Dress project she worked on, for instance, has

Designers are exploring the endless possibilities of embedded tech



mechatronic spider legs that "attack" when someone comes too close to the wearer's personal space.

Intel also worked with New York fashion brand Chromat on its Adrenaline Dress, which expands and collapses based on the wearer's body temperature and stress levels, as measured by the Intel Curie module. Made from 3D-printed panels and shape memory alloy, it is intended to mimic the way in which animals appear larger in moments of fight or flight, says Todd Harple, director of pathfinding and innovation strategy for Intel. "The dress silently grows by up to 30 per cent – almost like it's natural," he explains.

Both might be an exaggerated version of what you'd expect to buy in a shop, but the idea of something that changes shape is how it could be interpreted. Researchers are experimenting with reconfiguring the molecular structure of fabrics so as to create dynamic textiles that shift in form and silhouette. A future whereby the length of a sleeve or the hemline of a skirt can be adjusted is thus entirely possible.

From fashion's perspective, this sort of functionality makes wearable technology appealing. "Utility isn't something a designer thinks about – it's aesthetics. On the high-end designer level, everything is about how the garment looks," explains Drinkwater. "A garment that can help open your front door is not aspirational enough, but when we begin to tie technology back to aesthetic changes, it becomes more powerful."

Designer Richard Nicoll's light-up dress, created by XO (formerly Studio XO) in partnership with Disney for spring/summer 2015, is one example. Made from a fibre-optic fabric activated by high-intensity LEDs tailored within it, this was miles away from the flashing lights in garments we've seen on stage in the past, and more akin to a next-generation piece of couture. "This was the first time we saw technology used to really enhance a garment. It wasn't about tracking steps or heart rates, but using technology to make something beautiful," Drinkwater explains.

More recently, XO also worked with VFILES to create VFILES_XO, an interactive collection comprising fibre-optic apparel and accessories. Using an accompanying app, and thanks to an addressable RGB LED, the clothing becomes a vessel for content – enabling the wearer to change surface colours and download various patterns in response to music.

Fundamentally, it's not new technology, but rather a take on wearables that's less about the catwalk and more geared at commercialisation. What was key, says XO creative director and co-founder Nancy Tilbury, was developing something that would appeal to a Generation Z streetwear consumer.

"It feels like the right community. They're all digitally savvy, they're on top of things like rare sneakers and they're committed to innovation. They're looking at their clothes and saying, 'These need to get on the grid; when is this going to happen?'"

Although the cap and rucksack from VFILES_XO's sports lux line will be launched in stores in time for next season, Tilbury admits it's a longer road for apparel. "We know from the interest we've seen that if we had the stock, people would buy it, so that's amazing. We're not waiting around for luxury houses to dip their toe in any more, we're building our own brand instead."

For Drinkwater, things get even more exciting when you start thinking about garments communicating with one another. Rather than smart clothing being just an interface, they become part of the internet of things (IoT), able to interact with people, places or spaces. "There's no reason why consumers wouldn't be able to swap or trade patterns for instance, or go to specific stores to download exclusive prints," he says.

All of this also turns wearable technology into a sustainability conversation, helping to slow fashion in an age of overconsumption through the ability to update pieces so easily.

Another view links IoT data with environmental issues. One project that came out of the Digital Anthropology Lab at London College of Fashion connected clothing with pollution sensors across London. The wearer was not only able to see how dirty their T-shirt was becoming, but access an algorithm that determined when it needed to be washed.

Other emerging companies are focusing on ensuring the fabrics are less harmful in the first place through bioengineering. Modern Meadow, which is developing cultured leather, is one example. "If you think about the 20th century being one that facilitated a generation of materials that came out of the petrochemical industry – like DuPont creating Lycra – the 21st century is about biotech. The ability to engineer fabrics, created from nature's building blocks," says Suzanne Lee, chief creative officer at Modern Meadow.

Rather than synthetic polymers, these are materials created based on proteins or carbohydrates, and engineered so they have properties you couldn't have in nature. They also have enhanced aesthetics that get designers excited, Lee adds.

Another example is Bolt Threads, a San Francisco-based startup that is engineering spider-silk protein and spinning it into a yarn, adding new performance properties as it goes.

"There is huge demand for more sustainable materials, and excitement from designers for new technologies that could change the way something looks," Lee says. Modern Meadow is a couple of years away from market, but she believes such fabrics will be commonplace within a decade or two. "We are at the beginning of a new material revolution," she explains.

Indeed. Let's not forget that the moisture-wicking properties in our sportswear; the Lycra in our hosiery; even the range of synthetic fibres we wear, were once big leaps forward.

With funding and research, smart textiles through to bioengineered performance fabrics will soon be integrated into our wardrobes, too.

Above: VFILES_XO's sports line is made with fibre-optic fabric that's activated by LEDs

SIEMENS



A breath of fresh air for laundry care.

Discover the gentle power of active oxygen in the revolutionary iSensoric sensoFresh system.

siemens-home.co.uk/sensoFresh

Sometimes you simply want to freshen up a garment, without fully washing it. And that's precisely why we created sensoFresh. Thanks to the use of active oxygen, you can now remove odours from your clothing quickly in your washing machine, without using water or detergent. Even for sensitive, gentle care clothes or textiles that aren't meant to be washed. Finally, you're able to enjoy your life to the fullest - and your clothes will be refreshed quickly and effortlessly. For a life less ordinary.

Siemens. The future moving in.



GEORGIA HARDINGE SCORPIO SHIRT

Part of a series inspired by zodiac symbols, the Scorpio features a laser-cut scorpion detail on a chiffon raglan-sleeved blouse. The use of layering and shadow draws on traditional Japanese stencilling techniques – albeit updated with lasers. However, the precision cutting is only one technical aspect in producing this garment. Hardinge worked with a London-based pleating specialist to apply techniques typically used in paper sculptures to bring her scorpion to three-dimensional life. *£375 georgiahardinge.co.uk*

Other star signs in Georgia Hardinge's spring/summer 2016 collection include the Gemini skirt and Cancer dress



Fabric

Photography: MAX OPPENHEIM

ARC'TERYX VEILANCE BLAZER LT

Better known for its outdoor wear, Arc'teryx also has a technical apparel division, Veilance, which combines minimalist style with performance fabrics. This featherweight 300g blazer is wind- and water-resistant thanks to a blend of nylon and Lycra, which also enables a greater degree of movement over more typical tailoring. The matching Voronoi shorts share the same light yet robust engineering, and both garments are also machine washable. The Frame Composite shirt is made from moisture-wicking Merino wool with a stretch-cotton overlay across the upper back and shoulders. *Jacket £440; shorts £240; shirt £200 veilance.arcteryx.com*

WORDS: JEREMY WHITE

The Blazer LT uses 1.6mm micro-seams to further reduce the garment's bulk and weight



MARTINA SPETLOVA WOVEN COLLECTION

Spetlova's handwoven leather garments use smocking, weaving, hole punching and patchwork to create a three-dimensional impression – but she also incorporates ethics into each design. Wanting to be as responsible as possible with the core material, Spetlova works with the Centre for Sustainable Fashion and uses by-products from the meat industry, sometimes working directly with slaughterhouses. Her recent collaborators include Ecco, one of the world's most environmentally friendly tanneries, which runs its production on 75 per cent biofuel. *Fully woven sweatshirt £780; woven skirt with basket weave tape design £1,000 martinaspetlova.com*

Martina Spetlova is working toward creating zero waste in the production of her next collection

STONE ISLAND 45546 GARMENT DYED PIXEL REFLECTIVE JACKET

Stone Island has a reputation for innovation in textiles, and its research has led to the development of garment dyeing for reflective materials. Here, iridescent Nylon Metal fabric has been printed with a resin containing thousands of refractive glass microspheres. The garment dyeing colours the textile base, while the "Pixel Reflective printing" gives the jacket the ability to bounce back light from even weak sources for a dazzling effect. Finally, a special agent was added to the dye bath for an anti-drop effect, meaning water won't bead on the jacket's surface, running off rather than penetrating the fabric. *£550 stoneisland.co.uk*



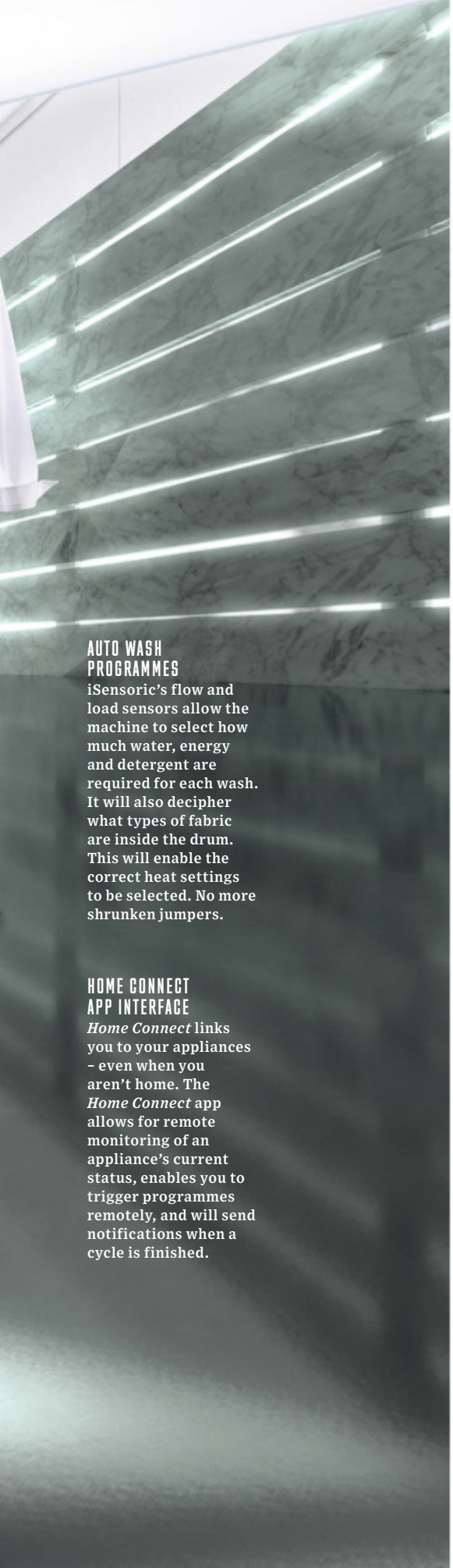
The jacket has a nylon-taped chest pocket and a windproof pouch on the arm

WORDS: JEREMY WHITE



PROTECT YOUR TECH

Siemens' range of washers and dryers are designed to take the stress and effort out of looking after your delicate clothes and wearable technology



AUTO WASH PROGRAMMES
iSensoric's flow and load sensors allow the machine to select how much water, energy and detergent are required for each wash. It will also decipher what types of fabric are inside the drum. This will enable the correct heat settings to be selected. No more shrunken jumpers.

HOME CONNECT APP INTERFACE
Home Connect links you to your appliances – even when you aren't home. The *Home Connect* app allows for remote monitoring of an appliance's current status, enables you to trigger programmes remotely, and will send notifications when a cycle is finished.

Siemens wants to create tools for a life less ordinary – technology that frees you up to live your life and pursue your passions. Which is why its line up of laundry appliances – including iSensoric, sensoFresh and Home Connect – are smarter than ever.

iSensoric's i-Dos system incorporates a collection of sensors that weigh the washing load and automatically doses detergent and softener. It also comes with Textile Guard, a collaboration with Nikwax that means you can waterproof outdoor clothing simply by running it through a wash dosed with Nikwax products. Outdoor Wear settings will ensure your synthetic clothing is cleaned, while any heat-bonded seams are protected from over-warming in the machine.

iSensoric's combination of Auto Programme and varioPerfect give you versatility – saving time or energy – or take decisions entirely out of your hands. autoStain knows how to deal with stains by sensing the molecular properties of 16 of the most common types, and selecting the optimum water temperature. It will deal with anything from cheffing mishaps and spilled wine to mud stains from a bike ride.

The sensoFresh technology includes a drum cleaning programme for a hygienic machine after 20 low-temperature washes. It also includes Siemens' dry refresh programme, which will make sure shrinking those delicate garments becomes a thing of the past. It also takes care of unwanted smells without using water or detergent, instead using active oxygen to break down the protein molecule chains that make up bad smells - removing evidence of kitchen odours, tobacco smoke or sweat. The Hygiene programmes make sure your clothes are really clean – even at 40°C.

We work, watch and play on the go. Now it's time to take control of your home appliances on the move as well. *Home Connect* is an app that allows for remote monitoring of an appliance's status, it also enables you to start wash cycles from anywhere – using your phone – and will alert you it's finished. It's life made easy.

For more information on Home Connect, sensoFresh and iSensoric, visit *siemens-home.co.uk/laundry-care*

VIRTUAL RUNWAY

From the couture catwalk to the shop floor, VR is giving fashion an interface makeover

High fashion brands have always enjoyed hosting exclusive events, from couture catwalk shows to extravagant parties. And, naturally, most happen behind closed doors for the privileged few. VR is starting to change this elite-only access, however. "Virtual reality allows anyone to experience that world," says Henry Stuart, CEO of VR studio Visualise, who argues this is one reason VR is finally being embraced by the world of high fashion.

Recent examples include an autumn 2015 show from Rebecca Minkoff which was filmed for VR, viewable via the Google Cardboard headset; Mercedes-Benz Fashion Week Russia, meanwhile, created a 360° experience in partnership with VR agency YouVisit. The film provided never-before-permitted access to the runway as well as global exposure for fledgling designers.

And with VR, locations could soon get a good deal more exotic than Russia, explains Stuart. "You shoot the whole thing against green screen and then, once in the VR setup, the models could be walking along a platform on a space station, or over a glacier, or through the Amazon."

But apart from allowing impossible backdrops, what does VR add to the catwalk experience? Being shot in 360 degrees means anyone wearing the headset can rubberneck as well as the rest of the front row, and looking up could reveal behind-the-scenes photos or notes on the collection. It's an evolving medium, but one might expect a blending of social media updates and comment that seamlessly mixes with the live footage.

This kind of immersive experience isn't just limited to catwalk couture, with global brands happily dipping a toe into the world of VR fashion shoots. In 2014, *Elle* magazine partnered with Jaunt to produce a VR cover shoot for readers to watch on Google Cardboard, and Visualise teamed up with lifestyle website Refinery 29 to produce a multi-city 360° fashion shoot for Samsung's *Milk VR* app. Even *Sports Illustrated* produced a three-dimensional shoot for this year's Swimsuit issue.

The retail space also looks set to benefit from VR. Tommy Hilfiger has recently introduced Samsung Gear headsets in many of its flagship stores, and Topshop, an early pioneer of VR, teamed up with agency INITION to livestream HD footage of its autumn/winter 2014 show to shoppers using Oculus headsets in its Oxford Street store.

VR headsets, although technically dashing, are not known for their supermodel looks. But this too is changing: in 2015, Dior unveiled its own make-up-orientated headset, "Dior Eyes", 3D-printed by DigitasLBi Labs France.

"I'd love to see a tie-up with a big fashion brand and Oculus," says Stuart, but he concedes: "It needs some brave brands to lead the way." And whereas VR has one foot on the catwalk, there's still some way to go before it becomes the darling of the global fashion scene – but it won't be long before the fashion world is at least experimenting as an industry with this technology.

"By the end of 2016, we can expect the majority of fashion brands, be it high fashion or retail, to have implemented some sort of VR experience," predicts Abi Mandelbaum, CEO of VR agency YouVisit.

Moving from 2D sketching to designing in fully immersive 3D could reinvent the way the fashion industry creates clothes. "Since you're not limited to the laws of physics in VR, you can walk around your design in space, you can see through and even storyboard your designs," says Phil Chen, originator of HTC's Vive project and managing partner at VR and AR seed fund Presence Capital. Enabling designers to think three dimensionally should also help further the development of 3D-printed garments and the adoption of new fabrics. **Libby Plummer**



Russia's next generation of designers got the 360° treatment for Fashion Week

THE TECH COMES HOME

Siemens' new avantgarde machine is smart looking on the outside, with smart sensors on the inside. It combines sleek looks and second-to-none washing capabilities.

The avantgarde machines have a full touchscreen LED display, which allows for easy controls and input. It's set at 25 degrees, for clear viewing.

Siemens' new avantgarde laundry products are designed to be as smart as the rest of the technology in your life – maybe even more so





The avantgarde i-Dos automatic dosing system ensures the correct measurements of detergent and softener are used, depending on the weight of each load and the materials being washed.

A built-in "3D sensor" detects imbalances in the washing drum, which can indicate water pockets that harm fabrics during the spin cycle. If so, spin speed is reduced automatically.

The 9kg capacity of avantgarde should help get your holiday load washed with minimal fuss and effort.

The smartphone in your pocket has had a responsive touchscreen for years, so why don't the appliances in your kitchen? Siemens' new avantgarde washing machine and dryer both feature intuitive user-interface design with multi-touch input. The screens sit at 25 degrees to the machines' front edge for easy reading and use.

The avantgarde machines are clever inside too. i-Dos is Siemens' automatic dosing system that knows when to add the right amount of detergent and softener to the wash. It gathers information from a series of internal sensors.

Customisable programmes allow washes to be as thorough or swift as you need – with cycles of 20, 30, 40, 50 and 60 minutes.

If you find yourself relying on the same programme options day after day, simply set that selection as a favourite. It takes just a single touch to recall the settings, so you can easily get back to what's important in life.

And no-one likes cleaning, so Siemens' avantgarde machines take care of themselves with drum-clean reminder, as well as aquaStop and aquaSecure mechanisms that are designed to ensure your washing machine never floods your kitchen.

You demand exceptional levels of technology and design in life. It's time to extend that mentality into the utility room. Siemens' avantgarde range has been designed with style and usability in mind. Efficient, subtle and stacked with sensors, the avantgarde washer and dryer do the thinking for you. Now all you need to do is get the clothes dirty in the first place.

For further information, visit siemens-home.co.uk/avantgarde

THE FEATURES

avantgarde machines have tens of different programmes and settings to make your life easier and your laundry experience better. The Favourite mode will remember your most-used settings, and varioPerfect can reduce wash times by 65 per cent, or energy usage by half. All this contributes to the avantgarde machines carrying energy efficiency ratings 50 per cent better than the top A+++ classification.

THE TECHNOLOGY

An array of sensors ensure the avantgarde appliances manage each laundry load as efficiently as possible. These machines can detect load volume and the kinds of textiles in clothes, adapting the washing process to the specific load. Additionally, the bleach in the detergent is activated faster with slightly higher temperatures. A temperature sensor enables the machine to cut washing times by 65 per cent and still achieve great results.

THE DESIGN

The user interface is set at 25 degrees for comfort of reading. A sleek, full touchscreen allows easy programme input, and the LED display is clear and bright. The door diameter of 51cm is wide enough for the biggest loads and the drum itself can hold up to 9kg of laundry. Slick, minimalist design wraps up the whole package, which is powered by an iQdrive motor that spins at 1,400rpm.

Siemens aims to ensure your clothes are as clean after each wash cycle as on the day you first got them – even after heavy use.

TESTED VR HEADSETS

OCULUS RIFT

Virtual reality headsets promise an overwhelmingly immersive viewing and gaming experience. The first model to gain attention, the Rift from Facebook-owned Oculus, is comfortable and lightweight. Headphones are built in: you flip them into place. The screens can be adjusted for your eyesight and work well with glasses. They are also sufficiently high resolution to look convincing and the graphics are consistently smooth. There was also perfect synchronicity between WIRED's movements and what happened on screen. Like the HTC Vive, Oculus Rift requires a high-end computer to make this work.

Oculus Rift offers games and VR movies, such as *Henry*, a cartoon about a cute hedgehog who couldn't hug anyone. It's an effective film, but it sometimes dragged. WIRED watched this while sitting on the floor and our numb bum was apparent long before the headset began to feel heavy.

In comparison, shoot 'em up games are much more active, requiring fast reflexes and a readiness to wave your arms in every direction. *Dead & Buried* is a Wild West-style shooting game where you must aim at targets all around you. The Oculus Touch controllers – button pads and a central grip in the hand – were sophisticated without being over-complicated. (Unlike the HTC, though, these are not bundled with Oculus Rift – an inferior Xbox One wireless controller is included instead.)

Epic Games' graphically advanced shooting title *Bullet Train* took the physical aspect a step further. To get round the fact that it's not practical to be walking or running with your eyes blind to the outside world, players navigate the game by teleporting themselves – a neat solution to a different kind of storytelling problem. *Bullet Train* was intense – despite the game allowing the player to slow down the bullets hurtling towards you. It was a good example of how much fun VR gaming can be when it's well executed. And the headset still felt nice and comfortable even after WIRED had been playing games for half an hour. **7/10** *£499 oculus.com*



HOW WE TESTED
Both VR systems were tested at length in large rooms. Points were awarded for headset comfort and lack of motion sickness when worn for extended periods.

HTC VIVE

Like the Rift, the Vive headset needs to be connected by wire to your computer. This means that it keeps the images smooth enough to minimise the risk of motion sickness (which dogged earlier VR headsets).

The Vive comes with two gaskets – the bit that touches to your face to keep out the outside world – so you can choose the better fit. Its party trick is that, unlike competitors, you can move about the virtual world by physically walking around rather than using joysticks, which makes for a more immersive experience.

It costs more than the Rift, but it does come complete with handheld controllers and wireless external sensors, which can be placed on tripods or just on shelves or tables. The helmet is not as neatly designed as the Rift, but it's just as comfortable and the displays are perhaps more convincing – especially during the demo set on the deck of an underwater shipwreck. Giant manta rays wheel overhead and, from nowhere, a whale swings into view, slowing and looking directly at you – by which time WIRED realised we were holding our breath.

The controllers are not as comfortable in the hand as the Rift's, but they still work well. In a space shooting game, they offered accurate despatch of alien baddies.

The Vive has a brilliant trick up its sleeve: it monitors the room and, if you stray too near a wall, chair or another person in the real world, virtual walls appear in front of you as a warning. Better still, if things become too overwhelming you can, at the touch of a button, show silhouettes of the room. VR can get a little intense, so this is a welcome feature.

Vive comes with two games, including a virtual painting program which is sufficiently versatile to keep you interested as you paint and splatter designs in 3D. HTC has also enlisted the allegiance of games developer Valve for the Vive, which augurs well for future releases. **8/10** *£689 htcvive.com*



Above: foam inserts and nose pads ensure the HTC Vive fits comfortably on the face – even if you wear glasses

WORDS: DAVID PHELAN

LIGHTER FASTER SMARTER

Pro cycling race kit just moved up a gear thanks to a bespoke approach and a slick new fabric

When tasked with designing the new WorldTour race kit for Team Sky, cycling stalwart Rapha had its work cut out. The brief? Design a performance outfit that can handle foul weather plus sweltering climates.

"The temperature changes are extreme," says Team Sky rider Ian Boswell. "You climb a hill at 15kph and you're sweating. But then you get to the top. You're at 1,000 metres and it's 2˚C. Suddenly, you're freezing. You need something that's going to breathe on the uphill but that you can zip up to keep warm on the descent."

"Team Sky doesn't talk about comfort," says Simon Huntsman, Rapha's head of R&D. "Racing isn't comfortable, it's about how much pain a rider can endure. This product was about achieving the best balance between protection and breathability. They asked us for a highly protective, wind and water resistant, breathable piece of race wear. Normally, that means laminate technology: two- or three-ply fabrics for wind and water resistance. But a laminate restricts airflow. That's a key part of performance: letting out heat and moisture during exercise."

The result? An innovative fabric that does in a single layer what others can only achieve with a laminate. It's made in four stages. First the yarn, nylon with nearly 50 per cent Lycra, is coated with a durable water repellent (DWR). Then it's woven into the fabric and brushed on the inside. Then it's dyed at high temperature, which shrinks it by 50 per cent for an incredibly tight weave. Finally, there's a second DWR treatment.

"The fabric shrinks so much that the gaps between the weave allow very little air to get through," Huntsman explains. "It's incredible to get this much protection from a DWR. It's also more durable because the repellent is applied twice."

The black of the dense weave also ensures the Pro Team Shadow kit looks striking, which gives a psychological edge. "If you want to go fast you have to look fast," says Boswell. "When you have good-fitting kit, you feel faster."

"We're the only team that gets everything custom-made," adds Boswell. "There's a performance benefit when it fits your body and your preferences. Everyone sits differently on the bike, so putting a seam or an aerodynamic fabric in a different place depending on a rider makes a difference. Maybe the future is 3D scanning? Finding the hot points of airflow around a rider and then building the kit around them."

Could this be an option for amateurs looking for the perfect fit and aerodynamics for club rides? "Bespoke fit is a lovely idea," says Huntsman. "We'd love to offer that, but there are challenges from a manufacturing point of view. One-offs are expensive. But it would be great to offer in a limited capacity for certain product areas. We do talk about it and I'm sure there will be demand." **Caramel Quin** *rapha.cc*

CYCLE SMARTER

Be seen, boss the stats and commute in style



SUGOI ZAP
The Zap uses a three-layer, pixel-reflective fabric that's covered with beads that are silkscreened to its surface. When artificial light hits it, you light up like a Christmas tree. *£99.99 sugoi.com*



SOLOS
These smart glasses are designed for elite cyclists and their coaches. As you ride, metrics are streamed to your team and displayed on the glasses' HUD. *$499 solos-wearables.com*



TED BAKER COMMUTER
This cycling suit is cut from a bi-stretch, wick-away, showerproof wool blend with cycle-friendly details. It also has an odour-eliminating finish. *£399 (jacket); £140 (trousers) tedbaker.com*


INDEPEN



The MOOV NOW (*top*) and Garmin Swim are augmented by smartphone apps that enable greater analysis of your stats

TESTED SWIM TECH

MOOV NOW

[*Left, top*] The multi-sport MOOV NOW monitors your movements and offers live coaching to improve performance – whether you're boxing, running, cycling or swimming. Admittedly, without a screen there's no instant feedback during your swim, but the accompanying app is worth logging in to after. It offers a detailed breakdown of every length, type of stoke, average and specific pace, turn time, even suggestions on how WIRED could save time on our freestyle turns. Impossibly good value given the amount of data collected, the genuinely helpful feedback and its versatility across types of activity. **8/10** *£45 moov.cc*
Lengths recorded **20**
Distance **1,000 metres**
Stroke per length **32**



MISFIT SHINE

Here, the standard Misfit Shine – a popular and stylish sleep and activity tracker – has been updated by Speedo to track lengths and distance in the water. Set the pool length before diving in and it will track your distance as accurately as the rest of the devices in our test group. But given the swim-specific branding, WIRED expected more from its app beyond simple stats. With no immediate feedback and the MOOV offering more detailed data, we can't recommend the Shine to a serious swimmer. **5/10** *£60 misfit.com*
Lengths recorded **20**
Distance **1,000 metres**
Strokes per length **n/a**

POOLMATE 2

Without an app or wireless uploading of any sort, the PoolMate 2 is more like a ruggedised sports watch than a hi-tech wearable – but it does a solid job, despite it being resolutely old-school. It tracks virtually everything a swimmer might need – laps, strokes, distance, speed, efficiency, duration, sets, rest time and calories – and it can be calibrated to your stroke length to work with open-water swimming. The menu system is a touch rudimentary and it suffers for not having an app for deeper analysis, but it can store 50 swims for data comparisons and is water resistant to 50 metres. **7/10** *£70 swimovate.com*
Lengths recorded **20**
Distance **1,000 metres**
Stroke per length **32**



GARMIN SWIM

[*Left, bottom*] It's attractive and super-light – although we'd stop short of calling it fashionable – and if your main sport is swimming, this is unbeatable. Comfortable, easy to use with a bright screen, even underwater, it tracks everything effortlessly. Just push the blue button and it monitors lengths, strokes per minute, stroke type, calories, strokes per length, time, distance and SWOLF (*see right*). Unlike the PoolMate 2 it can't track open swims, but the menu is easier to navigate. **8/10** *£104.99 garmin.com/swim*
Lengths recorded **20**
Distance **1,000 metres**
Stroke per length **40**

SWOLF

The most vital data for serious swimmers is a mash-up of swim and golf terminology. SWOLF – available on the Garmin Swim – combines the time for one length, plus the number of strokes it took to complete it. So, if you take 30 seconds and ten strokes to swim the length of a pool, your SWOLF score will be 40. And just as with golf, the aim is to improve your game by lowering your score.



The *Garmin Connect* app lets you compare SWOLF scores

HOW WE TESTED

WIRED took to the pool at the London Aquatics Centre wearing all four devices – two watches and two button-style fitness trackers. After 20 lengths of the 50-metre pool, the accuracy of data, including number of lengths, pace and stroke count, was compared. To try to confuse the kit, WIRED changed stroke (nothing to do with tired arms, honest) and swam ten lengths front crawl, five breaststroke and five backstroke. Each device was also rated according to ease of use during exercise, comfort and app features where applicable.

WORDS: CHRIS HASLAM

THE FITNESS INDEX





The UK is a nation of runners and riders. This data, supplied to WIRED by mobile fitness app *Strava*, breaks down all the runs and bike rides logged on the app in the UK throughout 2015. *Strava* users can upload their performances from wearables including Garmin, Polar, Suunto, MYZONE, Fitbit, Microsoft Band, Soleus and Timex, as well as from Android and iPhone devices. *strava.com*



8.4KM
The average distance male runners covered, per run

5.17
The average pace, in kph, of male runners in the UK

38MIN
The average time for runners to commute to work

7.2KM
The average commute distance for people running to work

7.0KM
The average distance female runners covered, per run

6.13
The average pace, in kph, of female runners in the UK

1,350,078
The number of running activities recorded in London throughout 2015 (obviously it's the most active – it has the most people...)

177
The UK's hilliest average run, in metres, located in Powys, Wales

11
The UK's flattest average run, in metres, in North East Lincolnshire

RUNNING / / CYCLING



-50.6
Percentage decline in logged rides during winter

23.7KPH
The average commute speed for cyclists in the UK

15.9KM
The average commute distance for cyclists in the UK

24.3KPH
The average speed per ride for male cyclists

41
The average distance per ride, in kilometres, for UK male cyclists

19.8KPH
The average speed per ride for female cyclists

34
The average distance per ride, in kilometres, for UK female cyclists

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WORDS: PAULINE BOCK. ILLUSTRATION: GIACOMO GAMBINERI

SIEMENS



Control your appliances. Anytime, anywhere.

Wi-Fi enabled Siemens home appliances with Home Connect functionality put you in touch with your home wherever you are.

siemens-home.co.uk/homeconnect

Now you can discover more exciting opportunities thanks to Wi-Fi enabled appliances and the intuitive Home Connect App. From easing the workload by letting the app decide on the best programme to run, to opening up completely new possibilities like preheating the oven on the way home from work. Making your everyday life more efficient and comfortable than ever before and allowing you to spend more time and attention on the things you really love to do. For a life less ordinary.

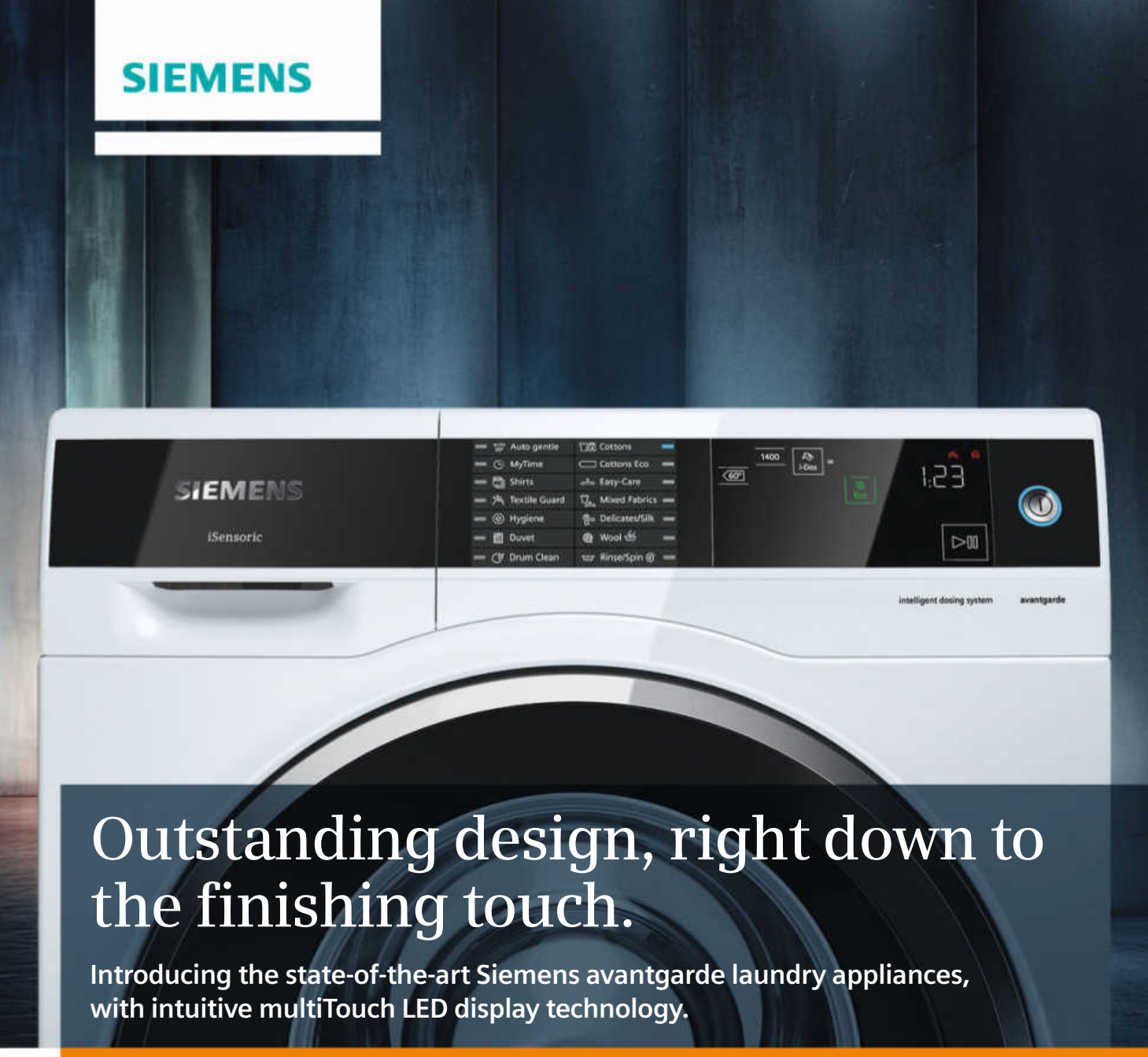


Your household in one app.

Home Connect

Siemens. The future moving in.

SIEMENS



Outstanding design, right down to the finishing touch.

Introducing the state-of-the-art Siemens avantgarde laundry appliances, with intuitive multiTouch LED display technology.

siemens-home.co.uk/avantgarde

The new Siemens avantgarde laundry range is loaded with innovation. Its inclined control panel and intuitive multiTouch LED display keeps functionality as simple as possible. Its automated self-dosing i-Dos system ensures your clothes get exactly the right amount of cleaning. And Siemens' ground-breaking iSensoric technology uses a range of intelligent sensors to automatically manage the entire washing process for you. Add a touch of brilliance to your home with Siemens avantgarde. For a life less ordinary.

Siemens. The future moving in.